THE AUSTRALASIAN

Radio World

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VOL. 9 . . . . . NO. 7 DECEMBER 15 1944

★ **Competitor's story of the Victorian amplifier contest.**

★ **English technician expounds high fidelity not desirable.**

★ **Filter design for pick-up tone correction system.**

★ **Our shortwave notes are a handy guide for listeners.**

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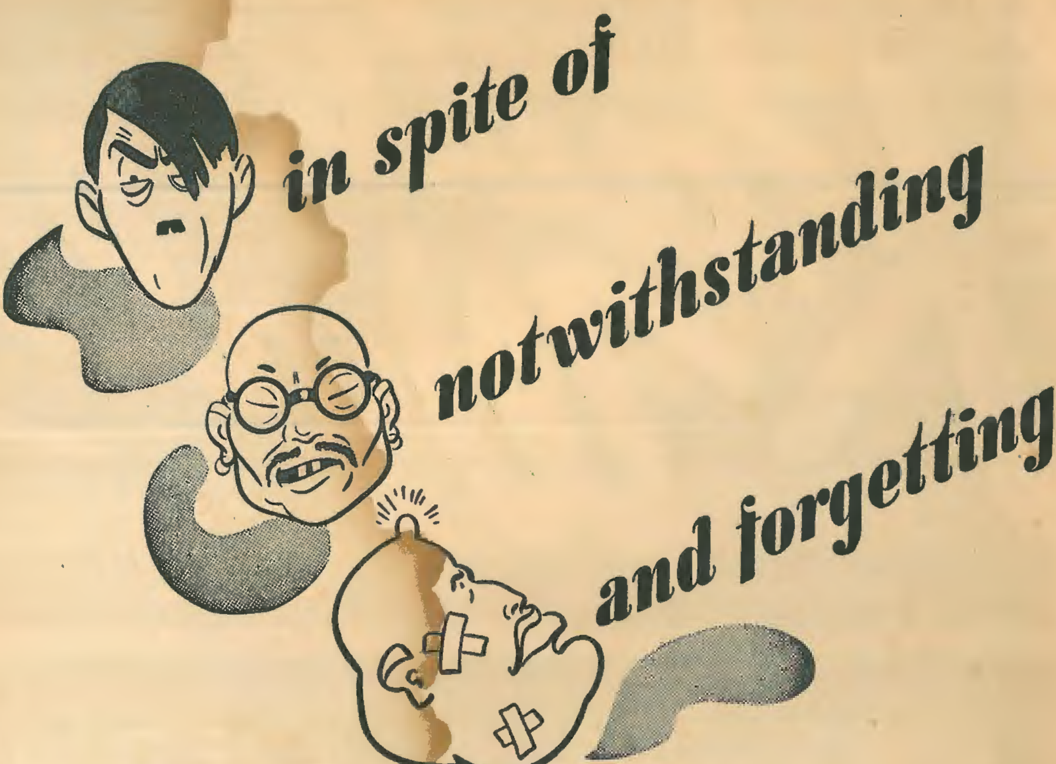

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EDITORIAL

Those of our readers who are enthusiasts on the subject of quality reproduction must be a little bewildered at the moment.

We had hardly finished publishing an amplifier circuit "to end all amplifier circuits" when along came the cathode-follower scare. To add to the confusion, then came the results of the Victorian Amplifier Championship, indicating that beam power valves, even with inverse feedback, do not give the practical results which can be calculated for them by theory. Even direct-coupled enthusiasts were disappointed. In fact, it might be said that the Victorian contest puts us all back about fifteen years in our theories.

To cap it all, along comes the latest issue of the famous *Wireless World* from London, with an article by well-known quality exponent H. A. Hartley, who now confesses that high fidelity reproduction is not desirable. The article is so complete in its coverage and so full of interest in every way that we feel bound to reprint it for the benefit of our many readers who are unable to obtain a copy of the English publication.

At the same time we feel that some sort of explanation is needed to clarify our policy in these matters. Some letters have been received from irate readers who claim that we seem to be deliberately misleading them by publishing contradictory stories in quick succession.

Briefly, our policy at the moment is to present all these theories as they come to hand. We leave it to you to use your own discrimination as to what you decide to follow.

CONTEST WAS KEEN

Inside Story of the Victorian Amplifier Championship

On Saturday night, 28th October, an excellent crowd, which was present at the new auditorium of Station 3UZ, Melbourne, witnessed the playing off of the nine finalists in the 1944 Victorian Amplifier Contest, sponsored by the Australian Radio DX Club in conjunction with the "Listener-In".

BEFORE discussing any pros and cons regarding the amplifier contest, I would like to pay tribute to the A.R. Dx Club for the way the whole show was organised. On the whole, the big night went like clockwork with no hitches, and not one competitor had an trouble in the way of breakdowns, etc. On such occasions one can always expect the worst to happen, but luckily blown filter condensers and other likely troubles were conspicuous by their absence.

Elimination Heats

Previous to the final night for three weeks continuously, on Mondays, Tuesdays and Wednesdays the eliminations in the heats of the three grades were held. Possibly, to the casual observer, this little fact escaped notice, but to me it stood out remarkably well. In army language it could be termed "esprit de corps" or, translated, simply means the team spirit. I was present on only four occasions previous to the final night, but on each occasion, the members of the A.R.D.X. Club were always there to give a helping hand to any competitor who needed assistance with heavy gear, such as baffles, heavy power pack equipment, etc.

Mr. N. H. Groves, the secretary of the Club is to be especially commended on the way he provided transport to at least four competitors, including myself, with cumbersome gear.

The friendly spirit which existed between competitors makes such contests really worthwhile and raises the status of this branch of Amateur Radio to a very high level.

A word of praise would not go amiss for the three judges, Mr. J. Walsh, Mr. Setford, of the "Listener In", and Mr. R. Buscombe, sound engineer, of "Velco" Sound Systems. Three solid weeks of listening to a crowd of amplifier fans including myself is no mean feat, and I for one did not envy them their job.

They really did a great job and toward the grand finale, all three looked very weary. So much for the preamble, now the results.

Grade 1.—Open to professionals and amateurs. Unlimited output.

The three finalists were Mr. A. Keogh, Mr. L. Wilkins and myself, in which I was lucky enough to obtain the judges decision. Being a competitor myself I do not consider it necessary or fitting that I should comment on any of the other competitor's amplifiers. Let it suffice that as far as possible I will attempt to publish in this issue some of the circuit diagrams used by other competitors, and as they all come to hand they will be published in forthcoming issues of this journal.

Grade 2.—Open to any home-built amplifier power output, not to exceed 18 watts.

In this grade there were six finalists, including the three mentioned in A grade, plus Mr. L. Lowan, engineer, of Veall's Service Dept., Mr. I. McLean, engineer at 3UZ, Melbourne, and Mr. Stevens, who makes no claim to being a technician, but who, nevertheless, surprised me with really good quality from a pair of 6V6G's preceded by the usual phase inverter and pen-

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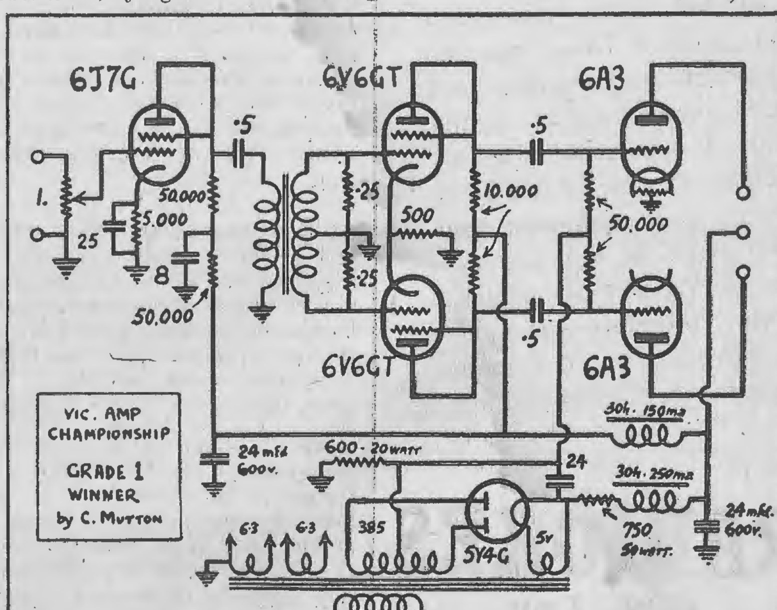

VIC. AMP CHAMPIONSHIP GRADE 1 WINNER by C. MUTTON

CONTEST WAS KEEN

(Continued)

tode priver and fitted with inverse feedback from the plate of one of the 6V6G's to the screen of the 6J7G driver tube.

In this grade Mr. S. McLean was successful in gaining the judges' decision, with Mr. A. Keogh and Mr. Stevens filling second and third place respectively.

Grade 3 was open to A.R.D.X. Club members only.

There were two finalists in this grade, namely, Mr. H. Groves, secretary of the Club, and Mr. L. Lowan, President of the Club.

In this case the judges gave their verdict to Mr. H. Groves with Mr. Lowan runner-up. Mr. Lowan was using beam pentodes, in fact, Mr. Stevens and Mr. Lowan were the only two competitors who used beam power tubes. The rest of us used triodes exclusively. Nevertheless Mr. Lowan's amplifier had a particularly good response to transients and a remarkably good lower register.

Having got over the first stage of the night, after an interval of about twenty minutes the judges announced that they had selected four amplifiers to play off in the champion of champions. These comprised Mr. S. McLean, winner of Grade 2, Mr. Keogh, who was placed second in Grades 1 and 2, "yours truly" and Mr. H. Groves, who won the A.R.D.X. Club section. After a brief play off in which each competitor played one recording of his own choice and then portion of "La Boutique Fantastique", Part 2, the judges awarded Mr. N. H. Groves the outright winner, Mr. A. Keogh, second, and Mr. S. McLean, third.

Much amusement was afforded the audience by the marked preference of Mr. Keogh and Mr. McLean for the record "The Shade of the Old Apple Tree," by Joe Daniels, which provided all "swing" fans present with food for thought.

Another amusing incident which provided much mirth among competitors, but which was not apparent to the audience, was the sight of two bananas pushed into the back of one of the baffles, these were used to plug a hole in the back of the baffle (no names are here mentioned) but I wouldn't advise the singing of that old song "Yes We Have No Bananas" at any meeting of the A.R.D.X. Club.

So much for a general description of a very pleasant evening. Now for a few facts which stood out.

(1) The three winning amplifiers in Grade 1, Grade 2 and Grade 3, were all transformer coupled in one way or another, and in each case the transformers were designed and produced by the Trimax Transformer Co., Melbourne, otherwise known as Cliff and Bunting, A.B.A.C. (no free advertising).

Good Transformers

This outstanding fact alone speaks volumes for the splendid quality of the products of Trimax Transformers. When it is considered that out of a total of 57 entries the outright winner of the contest, Mr. N. Groves, used both a coupling transformer and output transformer made by the aforementioned firm, Mr. McLean, Grade 2 winner, used the same coupling transformer, and myself a coupling transformer and output transformer of Trimax manufacture.

Personally, I would say without being in the least bit dogmatic, that in view of the results of the amplifier contest, transformer coupled amplifiers used with a good output transformer and providing the response of the coupling transformer is correctly designed, and more important still, correctly used according to the manufacturers data to give to the desired characteristics, it is possible to obtain reproduction equal to and in most cases better than the best resistance-coupled circuits. Many who favour resistance-capacity coupled set up say "What about the extra cost?" are completely biassed in most cases and seem to forget that it is necessary to resort to using an extra valve to provide phase inversion, plus the extra parts, trivial though they may be. So that the extra cost actually, if any, is only a few shillings, which is more than compensated for by the fact that a good transformer will give perfect balance and drive to the output grids, a condition rarely attained with a resistance-coupled phase inverter without the use of a cathode ray oscilloscope to guide one in getting correct balance.

In fact, I would go so far as to say that with one particular type of tube phase inverter which enjoys great popularity to-day by reason of its simplicity, it is practically impossible to obtain correct balance under any conditions.

At least that is what the C.R.O. tells me personally in the course of experiments I have made, and the cathode ray tube is an extremely good indicator of what goes on in an amplifier; in fact, one just can't argue against it.

The second point which stood out was the fact that every competitor used a crystal pick-up, demonstrating, I think, that for most purposes the crystal pick is capable of good results providing it is used correctly in regard to loading. I really think that many competitors spoilt their chances by not correcting their pick-ups to suit the response of the amplifier.

Acoustic Conditions

Thirdly comes a glaring example of what a change of conditions can do to the response or to be correct, apparently, change the response of an amplifier. During the eleminations the set of conditions were entirely different, inasmuch as the interior of the hall in the Herald building was absolutely devoid of draping, carpets, or absorption of any kind and in effect gave one the impression when listening to an amplifier with good high frequency response, that the upper register sounded harsh and even strident in some cases.

Added to the fact that on a listening test I would say that the average level which was set to the judges liking, would be in the vicinity of 5 to 6 watts, which was ample for everybody to hear. The average number of people who came to the heats would be, on an average, perhaps 20 or 30, certainly not more. Now take the final night conditions.

The new auditorium at 3UZ is a fine example of what acoustic treatment of an auditorium should be. For instance the walls are all broken up into various contours to minimize troublesome reflections, and are composed of what appeared to be some acoustically dead material after the style of "celotex" or "caneite."

The side walls of the stage were

By

CHARLES MUTTON

1 Plow Street, Thornbury, Vic.

draped with heavy curtains from the ceiling to the floor and the ceiling was fairly low. As far as I can remember the stage was only raised to a level of about 18 inches above that of the floor level where the audience were seated. The floor covering appeared to be a carpet of somewhere in the vicinity of one inch thick. So much for the description of the auditorium, and this describes the effect it had on the various amplifiers.

Before commencing the show we contestants were permitted to try the amplifiers out for level, position, and where possible tone compensation. On rigging my transformer-coupled job up and playing a test recording, I went to the extreme back row of seats in the auditorium and listened for the effect. This was my reaction. It was immediately apparent that at an output level of 10.5 watts the amplifier sounded like any ordinary four watt output job and I might add at this stage the auditorium was devoid of people. By the time 270 persons were seated and had filled the place to capacity I just can't tell what the effect would be at the back of the hall, but I have a fairly vivid imagination.

I would be prepared to say that to hear any amplifier under that set of conditions to real advantage, one would need every bit of 12 to 15 watts output.

As I had taken the precaution of calibrating my gain control against watts output at the voice coil previously, I knew that at the level the judges required me to play the test recording at, I was pushing out 12.5 watts approximately, and at that level, standing behind my own speaker set up, it was not uncomfortably loud.

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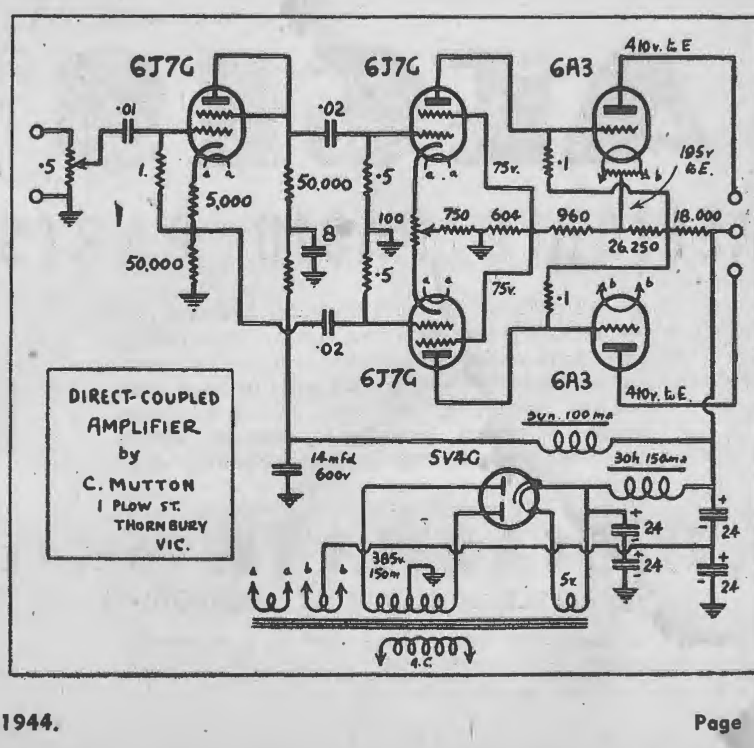

CONTEST

(Continued)

The speaker set up was the Amplion D-Phonic speaker kit, comprising a 12P64 which handled the lower register up to 400 cycles and the 8P90 for the highs which handles from 400 to 10,000 cycles the cross-over point being chosen at 400 cycles.

The speakers were housed in an infinite baffle and were arranged so that either of the two amplifiers entered could be plugged into one speaker system.

As mentioned previously, the output transformer was a Trimax type TA649 high-fidelity job with a tapped secondary to accommodate most of the more common voice coil impedances.

This transformer, like its mate the interstage transformer, were both of pre-war vintage and are unobtainable to-day due to defence requirements.

For those interested I have reproduced the circuit herein, from which it can be seen that the amplifier is perfectly straightforward in every detail, the resemblance to Mr. Groves' winning amplifier is practically identical, excepting the two push-pull drivers preceding the output stage, in my case were beam tetrodes connected up as triodes.

Under these conditions with ten thousand ohm plate loads only draw about 10 mA plate current each.

Overload Distortion

Actually it was possible to drive the output stage to overload point at 13.5 watts where the distortion due to overload was severe, but up to this point the distortion as measured with a GR noise and distortion meter did not exceed 1 per cent., and at 10 watts was non-existent. The 6A3's were run on semi-fixed bias by inserting a 750 ohm 30 watt type DJA "IRC" resistance in the negative HT lead.

This type of resistor lends itself well for the purpose as it is adjustable. For a plate voltage of 300v it was adjusted for 60v negative bias. Under these conditions of class ABI operation the 6A3's draw about 40 mA per tube and are rated at 13.5 watts.

Thus the power supply requirements are quite economical and are safely handled by 385-385v one hundred mill transformer, with appropriate filament windings.

No provision for balancing the 6A3 plate currents was made as the pair in question were evenly matched.

The .25 meg. 6V6 grid resistors 10,000 ohm plate resistors and the 50,000 ohm grid resistors for the 6A3's were matched to .25 per cent. tolerance, and by using a separate power supply with oversize filter chokes, there was not the faintest suspicion of hum in the amplifier, with an open input and the gain control flat out.

Perhaps I'm fussy, but that's how I like it to be.

It will be noticed that I have inserted a resistance in series with the output of the 5V4 rectifier, this was necessary as I was using a 150 mA transformer 385-385 secondary which was giving approximately 410 volts at the rectifier output. As the transformer was intended for use with an electrodynamic speaker it was necessary when using "permags" to drop the volts with a 750 30 watt resistor, this value worked out beautifully and gave me 300 volts at the plates.

The pick-up used was the well-known B10 piezo-astatic crystal, which obviously needs no comments.

Frequency Response

Just as a matter of interest for those readers who would like to know what this amplifier is like as regards frequency response, here are the figures taken at various stages in the development of the amplifier.

After completion and wired up hay-wire fashion to facilitate alterations, the job was hooked up in the following manner. Using an ordinary commercial type of output transformer a non-inductive resistance of 12.5 ohms was hooked across the secondary winding, thereby forming a resistive load of correct proportions which would reflect back to the primary side 5,000 ohms plate to plate. Actually working 6A3's with fixed bias the correct load is rated at 3,000 ohms plate to plate, but as the output transformer is often used for other set ups requiring 5,000 ohms load it was used as such. The effect being less output at high levels but with a reduction in distortion.

A BFO was fed into the input terminals and set at .25 volt output level, then a 1000 cycle signal was fed in from the BFO and adjusted so that the output meter, which consisted of a Weston 20,000 ohm per volt job with a calibrated decibel scale, read zero level at 1000 cycles. Keeping the input constant, the BFO was varied throughout the audio range from 20 cycles up to 12,000 cycles. The response was perfectly flat with no variation from 20 cycles up to 4,000 where it was down 1 db, increasing in 1,000 cycle steps, the response gradually tapered off until at 10,000 cycles it was down 7 db. This constituted serious attenuation and was most apparent even when playing records.

Suspecting the output transformer I connected the output meter across the 6A3 plates and ran over the audio range again, this time was a different story, the amplifier was virtually flat from 20 to 13,000 cycles with less than .5 db. variation, which in any language is good. It had thus been proved that the high-frequency attenuation was due to the output transformer. I now hooked up the TA649 and ran over the same procedure again, finding this time that the high frequency attenuation had completely vanished and that the overall response from input to output including the transformer was absolutely flat.

A model 208 Du Mont Cathode Ray Oscilloscope was then connected across the resistive load at the O.P. transformer secondary and the waveform examined at various frequencies, everything proved satisfactory. Up to 13 watts output, here commenced the overload point in the output stage, as was evidenced by a flattening of the peaks of the sinewave.

The pick-up used provided a boost at the lower register where needed, so it was not necessary to use any bass compensation. But as the usual practice is to provide a rising response at the high frequencies a filter was put on the input circuit to the 6J7 grid to provide about 5 db lift at 5,000 cycles.

As most people know a flat amplifier to the ear sounds pretty awful, hence must be compensated in order to appear pleasant to the listener.

So much for the transformer coupled job, now the direct coupled job which was entered in Grade 2.

Little did I realise when I featured an article last month on direct-coupled amplifiers that the response to that article would be so terrific. Without any exaggeration, to date about 120 letters have arrived from all parts of Australia, even Tasmania and New Zealand. To those

(Continued on page 10)

HEROIC RADIO OFFICERS

The Lloyd's War Medal for bravery at sea has been awarded to three radio officers.

Senior Radio Officer C. S. Marshall received his medal for outstanding courage and devotion to duty. By employing every means and improvisation available he did all that was possible to send out a distress message when the ship in which he was sailing was torpedoed and severely damaged.

Senior Radio Officer C. S. Marshall sacrificed his life by remaining at his post after the crew were ordered to abandon the sinking ship. He managed to repair the transmitter and get a message through to one of H.M. destroyers and was not seen again.

Chief Radio Officer S. D. Haines also stayed behind after the crew had been ordered to leave in an effort to repair the wireless gear and to send out a distress message.

Chief Radio Officer R. F. Cole receives the M.B.E. Although injured and dazed by the explosion which wrecked his ship, he struggled amongst the debris in the wireless room to get away a distress message on an emergency set, and left only when ordered to his boat by the Master.

CONTEST
(Continued)

many readers of this journal who so kindly wrote and expressed their appreciation I take this opportunity of thanking them one and all for their very encouraging remarks, and it is with extreme pleasure that I say that through the columns of "Radio World" I have made many good friends whom I have never seen. The fact that unbeknown to me so many are interested in d.-c. amplifiers is sufficient in itself to warrant bringing the subject up again for discussion, together with a circuit identical with last month's job, but with triodes in the output. This was the job I entered in Grade 2 of the Amplifier contest.

I will attempt to provide more d.-c. amplifier data in this journal when we have finished with the circuits of the nine finalists.

First of all let me say this, that replacing the 6L6G's with triodes was a vast improvement. I already knew this before the last circuit was published but as it is only possible to get about 7 watts out of triodes in this set up, it was thought that the beam pentode job offered better posibilities as far as output was concerned. But, for those who are interested in quality, plus everything at about 6 watts, this is the job. I can only invite those who are sceptical to at least give it a try before condemning the direct-coupled amplifier as a relic of the past. Many enthusiasts in the audience at the contest came along afterwards and expressed interest in the job and similarly those who heard it under different conditions in the heats and at home in the workshop are now converts to direct-coupling.

The fact that it made the finals in a total of fifty-seven entries is one factor in its favour and proves that although it was unplaced in Grade 2 it was by no means disgraced. In fact (this is only my own personal opinion—it was only by an unfortunate set of circumstances that it did not do better. As Mr. G. Neilsen, laboratory engineer at Kingsley Radio aptly put it, "I'm afraid one can't send a boy out to do a man's job." Which meant simply this.

Overloading

The distortion which was present when the amplifier played off was due purely and simply to overload of the output stage. As in the other amplifier, the gain control was calibrated against watts output, I was already putting out about 6 watts when the judges requested that I turn the gain up, the 6A3's theoretically couldn't put out any more without being overloaded by the 6J7 drivers. Looking at it the other way, had I cut the input down from the pick-up I couldn't have driven the 6A3's to maximum undistorted output, so that it just resolves into a vicious circle.

The whole answer to the story

was I just didn't have enough power output for the acoustic conditions of the hall, and in attempting to overcome this, the output stages became overloaded.

Therefore I still say that the direct-coupled job was by no means disgraced.

Referring now to the circuit diagram it will be seen that by comparing it with the previous 6L6 job the set up is much the same, except for the fact that the resistance values are different due to the plate current of the two output tubes being different. An improvement has been added in the way of a single control balancing arrangement whereby the plate current of the 6A3's can be equalized even when the individual tubes are widely mismatched.

Meters Desirable

The writer strongly advises the temporary use of 2 0-100 mA meters in the plate circuits until the correct balance is found and then the meters may be removed, but don't neglect to insulate the shaft of the 100 ohm balance control from the chassis, failure to do this will result in certain damage to one of the 6A3's. The amplifier when first switched on has a momentary loud hum level, but as soon as the 6A3's balance up the hum is non-existent.

In connection with the power transformer specified the voltage of the secondary 385-385 was really too low for direct coupling and even using a 5V4 low-impedance type of rectifier which gives approximately 20 volts more than the conventional 5Y3 or 5Z3 under the same conditions, the maximum voltage on the 6A3 plates measured between plate and the centre tap of the 6A3 filaments was 215 volts, which is 35 volts too low for standard class A operating conditions.

With 6A3's the voltage at the centre tap of the filaments must be 195+ above ground so that the voltage on the plates plus the 195 V constitutes the total drop across the tube to ground, hence the voltage from plates to ground is 215 + 195 which is a total of 410 volts

As explained in a previous article, the output grids are at the same positive potential as the driver plates, i.e., 150 volts and as we have raised the centre tap of the 6A3 filaments 195 + above ground we have 195V — 150 which leaves a negative bias of 45 volts, which is what is required.

To attain the full rating of 7 watts under strict class A conditions a power transformer with a secondary giving about 420 aside is really necessary. But for my own purpose, which is to use at home for real quality reproduction, I consider that a standard 385-385 job will give more than ample voltage to do the job.

If anybody can honsetly say that they get 5 watts on the secondary side of the output transformer then they are getting lots of sound and, to be quite candid, there are not too many who are getting that much into the secondary side. The whole trouble is that many fail to realise how much loss really takes place in the ordinary transformer.

A good home test under average conditions is that most people could not listen to even one watt of clean undistorted output without feeling that it was uncomfortably loud for average home use.

Five watts of distorted output kicks up a terrific din but one watt of clear sound will put it in the shade as far as apparent loudness is concerned.

Getting back to the circuit it will be noticed that the resistance values in the voltage divider network are somewhat odd values. This fact led a few people I know to complain that they weren't standard sizes. While admitting that fact my views are that it is only necessary to series two of the nearest commercial sizes which will give somewhere near that value.

The Values Are Not Critical

In my own case the 18,000 ohm was made of a 15,000 ohm in series with a 3,000 ohm. The next one a 25,000 in series with a 1,000 ohm and a 250 ohm. These are all one watt sizes and readily obtainable.

The 960 ohm and 604 ohm are the only two which carry appreciable current which amounts to 120 mA for the two 6A3's, plus about 4 mA bleed current.

These two resistors come to a total of 1,564 ohm which in this case were made up of two 750 ohm type DJA 30 watt L.R.C. adjustable wire wound resistors in series, with the adjustable tap on the second resistor set at 75 volts for the 6J7 screens. The resistance was 64 ohm low, but in this case the beauty of using triodes is that the bias is not critical within certain limits.

With 6L6's one has to be a little more careful in this respect.

However, the two 750 ohm jobs were left in and proved to be o.k. as long as the 6A3's don't draw more than 60 mA each when balanced everything will be alright. Use of the two meters will automatically take care of this point.

The voltage for the phase-changer is taken off through another choke from the low side of the first one, this was done to eliminate any possibility of upsetting the voltage distribution in the direct-coupled portion of the circuit. Although I did not try the scheme, it should be possible to cut this choke out and run the 100,000 ohm decoupling resistor for the phase-changer direct to the high tension. Any interstage transformer of good quality could be used instead of the phase-changer, in which case

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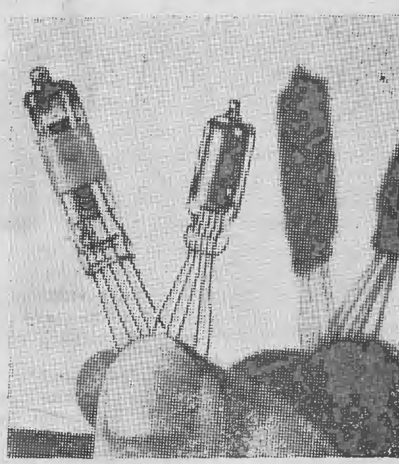
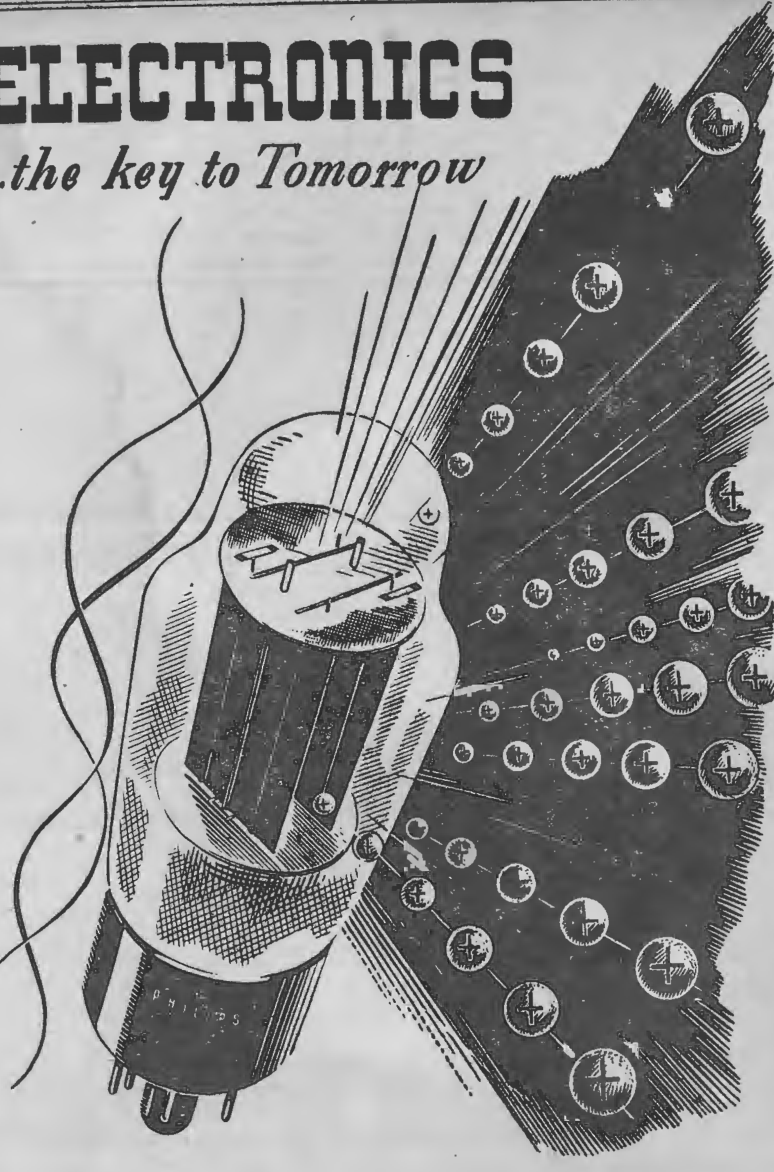


MINIATURE VALVES

The above illustration shows a pair of "Microtube" valves of the type used in American "personal portables" and hearing aids. The filament rating is 22.5 mA at 0.625 V and the normal anode voltage is 4.5. The valves are designed for wiring directly into the circuit and the dimensions are 0.4 inch diameter and 1⅛ inch long.

ELECTRONICS

..the key to Tomorrow



THE radio valve is really an electron tube. It controls *electrons*—the smallest particles of matter known to science. It operates in the world of sub-atoms, where these electrons travel at speeds approximating the speed of light—186,000 miles a second!

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PICK-UP PRINCIPLES

■ In Part 1, we saw that moving-iron and moving-coil pick-ups both possessed two main peaks due to resonance.

ONE of the resonance peaks is in the bass register and may be anywhere from 5 to 150 cycles per second. This bass peak may be desirable in order to obtain a certain amount of bass boost (the bass is attenuated in records), but it's ever so much better if the bass peak is outside the audible range, at say 5 to 30 cycles per sec., and the bass boost is obtained by a filter of some sort. Such a filter may be termed an equalizer if its characteristics are fixed, or a tone control if its characteristics are variable.

Upper Treble

The other resonance peak is in the upper treble register and is always within the audible range. If the resonant frequency is very high in the non-useful range (above 6000 hertz) the upper highs can simply be cut-off by the common condenser-shunt type of filter. However, should the peak be around 2,000 to 3,000 hertz, where it is in many cheap pick-ups, then a tuned filter is required to remove a small band of frequencies around the resonance point. The attenuation produced by this filter must not just be equal to the size of the resonant peak—it must be much greater for two reasons: First, due to resonance, notes at that frequency are prolonged and are therefore much more audible even if of only normal intensity. Second, scratches on the record and transients excite the resonant frequency producing spurious notes of that pitch.

Tuned filters are usually very cumbersome and liable to pick-up hum by induction. They contain large air-cored inductances which must be "just right" in value if they are really going to do a good job. Our snag is that the characteristics of cheaper pick-ups vary with age—magnets become feebler, rubber gets harder and also needles vary so that a filter that is quite o.k. one day will be not so helpful another day.

Let us consider the simple kinds of filters first.

Resistor Shunts

Most amplifier enthusiasts know that "scratch" appears to be reduced and that "highs" are attenuated if a resistance of from 5,000 to 50,000 ohms is connected in parallel across a magnetic pick-up. What happens is that the resistance is really in series with the leakage inductance of the pick-up bobbin and the voltage across the resistor is a fraction of that supplied by the pick-up. The fraction varies with frequency from nearly unity at low frequencies and is given by

$$\frac{R}{\sqrt{R^2 + 4\pi^2 f^2 L^2}}$$

where R = resistance and L = inductance in henry. The smaller the value of R, the greater the attenuation at high frequencies. Besides reducing the highs the resistance also helps, very slightly, to increase the damping.

Condenser Shunts

Another simple "equalizing" device is to connect a condenser of from .001 to .03 microfarad in parallel with a magnetic pick-up.

Here the effect produced depends on the size of the condenser, the upper resonant frequency, and the leakage inductance of the bobbin.

Unusual Effect

If the upper resonant frequency is high as in a good pick-up and the leakage inductance is large the small condenser has a very beneficial and unusual effect: The inductance and condenser form a tuned circuit thereby increasing the output at one frequency just as a tuned circuit acts in a radio receiver. It can sometimes be arranged to boost the response above the armature resonant frequency. Then a little of the usual high attenuation can be used to even out the response giving genuine high-fidelity reproduction.

With a larger value of condenser, the frequency at which the boost is obtained is lower and this is usually undersirable except where very worn records are being played and a good response over a narrow frequency band is required.

Quite an effective tone-control can be made up from a variable re-

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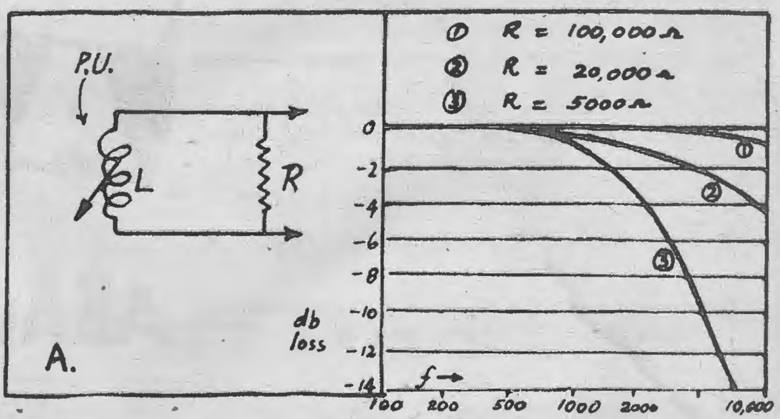


Attenuation of "Highs" by Resistor Shunt.

PICK-UPS

(Continued)

sistor shunt (say ½ meg. potr.), a fixed condenser of from .002 to .005 mfd. (found by trial) and a condenser-variable resistor filter, **all in parellel.** The condenser-resistor shunt could consist of a .02 mfd. condenser with a ½-meg. potr. in series.

Tuned "Scratch" Filters

In order to design a tuned acceptor-circuit filter, the resonant frequency must be known fairly accurately (to within 2%). The response at a frequency equal to some fraction of the resonant frequency must also be known. Also the amount of attenuation to be obtained must also be known. These three facts enable the calculation of the three components L, C and R of the acceptor circuit. (R may be the resistance of the inductance coil or it may be that together with a fixed resistor). A typical set of data might be:

Resonant frequency = 4,000 hertz
Attenuation required = 12 db.
Response at 3,000 hertz = 3 db (that means the filter must reduce the response at 3,000 c/s. by 3 db.

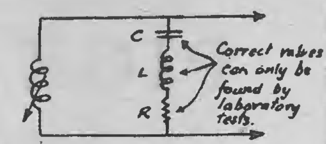
To simplify calculations, there may be assumed to be a large resistance each side of the point of connection of the filter. Let the resistance of the input side be, say 250,000 ohms.

Then for 12 db attenuation (voltage reduced to one quarter) the resistance of the filter must be one-third of 250,000 ohms, say 80,000 ohm.

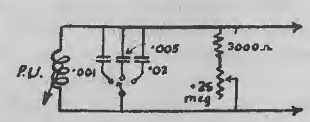
For 3 db reduction of voltage by 30% attenuation at 3,000 hertz the reactance of the filter must be **approximately** 250,000 ohms and will be given by

$$\frac{1}{2\pi fc} - 2\pi FL \div 250{,}000 \text{ ohm} \quad (f=3000).$$

(actually the reactance should be somewhat less) but the resonant



Conventional Type of "Scratch Filter". (Values are very critical).



A dual-acting filter for control of "highs" and "scratch".

frequency is 4000 hertz, therefore

$$4000 = \frac{1}{2\pi\sqrt{LC}}$$

In practice the following values

might be used and one variable, say C adjusted by trial and error:
L = 20 henry, C = .001 mfd., R = 75000 ohm.

These values are widely different from the usual .003 to .01 mfd. and .1 to .5 henry which are often found to be so disappointing. These latter values attenuate too great a range of frequencies and cause lack of brilliance and general "muffling."

It is not easy to wind 20 henry inductances without a certain amount of distributed capacity creeping in and so tuned filters are not very successful except in the case of low impedance pick-ups where they are employed before the step-up transformer.

Bass Equalizers

In order to get sufficient playing time on a record, the bass is attenuated. The rate of attenuation varies considerably but is generally about 6 db per octave, this corresponding to constant amplitude recording. This means that below some mid-frequency (usually between 200 and 550 hertz) the response falls off considerably, the power output being reduced by a factor of 4 for each octave the pitch goes down. The best way to make up for this loss is to use a resistance-capacity network either before or after the first valve in the amplifier. Unfortunately the resistance capacity network lowers the response at all frequencies in its process of levelling and so more gain must be used in the amplifier. This extra gain demands an extra valve which may give the home constructor quite a bit of worry over hum and oscillation.

Another way to boost the bass is to use a pentode voltage amplifier valve and to place in its anode circuit as part of the load, a tuned circuit consisting of a very large inductance (say 500 henry) of fairly low resistance (less than 1000 ohm) and tuned by a condenser connected in parallel. The boost occurs mainly at one frequency which, of course, may be calculated from our formula

$$f = \frac{1}{2\pi\sqrt{LC}}$$

The amount of the boost depends upon the dynamic resistance of the tuned circuit and this dynamic resistance may be calculated from:

$$\text{Dyn. Res.} = \frac{L}{CR}$$

where C is the shunt capacity and R the resistance of the choke. Supposing the choke has an inductance of 250 henry, a resistance of 5000 ohm and is tuned by a .05 mfd. condenser. Then the dynamic resistance is $250 \div (.05 \times 10^{-6} \times 5000)$ which is 1 megohm. If the usual anode resistor is .1 meg. and the following grid resistor is 1 meg., then the boost produced is approximately 12 db (at about 50 c/s.).

Elaborate Filters

An ambitious filter design might include some or all of the following:

Bass-boost network.

High-boost network.

High-frequency cut-off filter to remove frequencies above a certain limit, say 6,000 or 7,000 c/s.

Acceptor circuit to remove the slight boost due to torsional resonance of the arm.

Rejector circuit (in parallel) to compensate for slight drop near the torsional resonance.

Testing of Pick-Ups

A complete test on a pick-up involves first the measurement of the **compliance** at the needle tip. This is to ensure there will be no undue record wear. The compliance is measured with a "travelling

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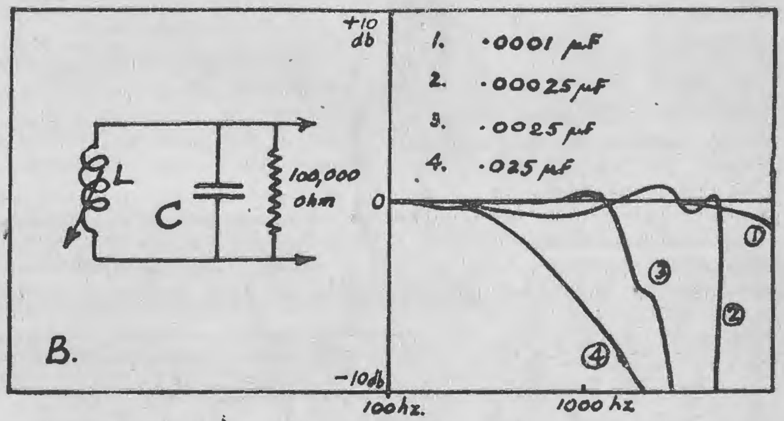
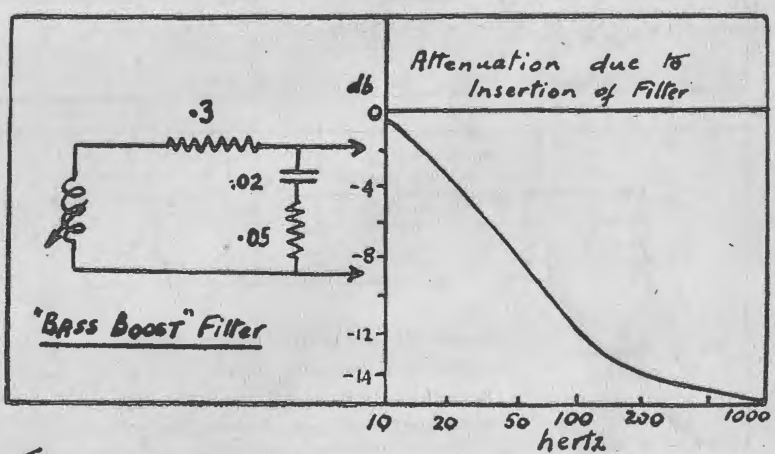


Possible Results of a Condenser in Parallel.
(Actual Results vary largely with Type of pick-up)



This type of equalizer usually demands an extra valve

PICK-UPS

(Continued)

microscope," the deflection of the needle tip produced by a side-thrust of so many milligrams being noted.

Then the **thrust** on the record is measured, again to check for record wear.

Now come the electrical tests:

With the pick-up connected to an amplifier and speaker, the needle is moved to and fro, about .005 inch and "wooshy" sounds due to discontinuities are listened for. Now an oscilloscope is connected and a resistive load is applied to the amplifier. The needle is flicked and the path traced by the light dot noted. This indicates the degree of damping. In a poor pick-up the spot might oscillate three or four times or not at all. If the pick-up is "critically damped" about three-quarters of an oscillation is seen.

The response curve is now obtained. An amplifier with either a flat response (and by flat, I mean actually known to be flat and not copied from a circuit supposed to give a flat amplifier!) or a known response is used. A high-grade vacuum tube voltmeter is used to measure the output. Some voltmeters require correction for frequency. First a standard record with a number of discrete frequencies is used and the response curve from 50 to 6000 hertz is plotted. Then a record with a continuously variable frequency is used enabling odd parts of the graph to be filled in.

In all these tests, the pick-up is shunted by the condenser or resistor it is supposed to have under actual operating conditions. The type of needle is also noted in the report on the test.

I have seen reports on pick-up tests that omitted such vital features as type of needle, load across pick-up, and whether the graph supplied made allowance for the usual bass attenuation or not!

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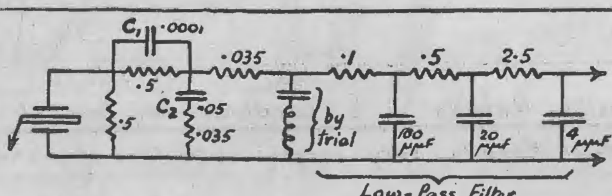
"Applied Acoustics," by Olson and Massa.

"Australasian Radio World", Jan., 1943, and Jan., 1944 (Pick-up design); Nov., 1942 (Reproduction from Pick-ups).

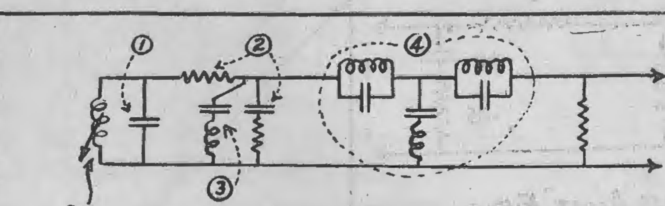
"Radiocraft," Nov., 1943 (A moving-coil design.)

"Radio and Hobbies," Vol. 2, No. 10 (2-coil pick-up).



C1 controls high-frequency response between 1000 and 5000hz.
C2 may be shunted by 1 meg. potr. to vary response of the "very lows".

Elaborate Filter for Crystal Pick-Up.



1. With pick-up gives boost at 5500hz.
2. Bass boost network.
3. Reduces response at 5000 hz.
4. Low pass filter with 6500 hz. cut-off.

An Elaborate Filter for a Good Magnetic Pick-up.

CONTEST

(Continued from page 11)

the grid resistors could be reduced to .25 meg and shunt feed the primary in the same manner as the other circuit shown herein. In conclusion this direct-coupled triode amplifier should answer the requirements of many of those readers who were after this circuit and who I have not yet answered due to the fact that I have been tied up with the contest for the past six weeks. However those readers are not forgotten, and each will be answered in turn. Should readers be interested in a circuit of a 30 watt triode direct-coupled amplifier utilising two separate power supplies and using fixed bias in the direct coupled stage I will endeavour to make a feature of this in a forthcoming article.

Finally, Mr. N. H. Groves, the winner of the champion of champions prize has permitted me to publish the circuit of his winning entry. Mr. Groves used a Rola G12 speaker mounted on a large irregular flat baffle. The circuit reveals that it is perfectly straightforward in every detail and follows standard practice. The pick-up used was a crystal type and much similar to that used by most other competitors. A point worthy of notice with Mr. Groves amplifier was its extremely good electrical layout and excellent method of shielding the input in a separate compartment and the beautifully neat appearance of the wiring. It is really a pity that more enthusiasts would not follow in his foot steps and try to at least make their jobs look respectable. Nothing looks worse or is apt to cause a bad impression than to turn up a chassis and find a hopeless conglomeration of wires, dangling resistors, etc. It is just as easy to make a good job as it is to do the thing in a slovernly manner.

So much for the 1944 Amplifier Contest, it affords me great interest to find some of the lads are at it already in preparation for the expressed intention of the DX Club to run a contest next year. Amplifier enthusiasts are certainly gluttons for punishment. personally, I need time to recover from the recent one!

VICTORIAN CHAMPIONSHIP

Official Report as Published in "Listener In"

WE present to amplifier enthusiasts the circuit and full technical details of the Champion Amplifier in the 1944 Victorian Amplifier Contest conducted by the Australian DX Radio Club in conjunction with The Listener In. The amplifier, owned and built by Mr. Harry Groves, of Heidelberg, makes use of triode valves throughout. The circuit is simple and straightforward and anyone with some small knowledge of radio could build it for himself in a few hours.

Before proceeding with the details of the winning amplifier it is interesting to note that of the nine amplifiers appearing on the final night seven of them employed triode type output valves. Pentode amplifiers were placed third in Grade 2 and second in Grade 3, but did not gain a place in the Championship heat.

Transformers Popular

Another interesting feature of the contest was the fact that a large proportion of the nine amplifiers used transformer coupling in at least one stage of the unit. Mr. Keogh's and Mr. McLean's amplifiers which were runner-up and third respectively in the Championship, both used transformers exclusively.

Mr. Groves' amplifier employs transformer coupling in the first stage. Baffle designs varied greatly over the contest. Both winner and runner-up used fairly large flat baffles, whilst Mr. McLean used a type of folded horn.

Flat Baffle Best

Mr. Mutton, Grade 1 winner, employed a very large infinite baffle and Mr. Lowan, who was placed second in Grade 3, used a baffle of similar type. Taking the results all round, the conclusion seems to be that a very large, flat, irregular baffle gives best performance. All of the infinite baffles heard had a peculiar boxed-up effect on the middle and lower registers.

Many of the audience present on the final night expressed a desire to hear Mr. Mutton's direct coupled amplifier on a flat baffle instead of on the large infinite baffle with which he won Grade 1.

Six Valves Employed.

However, to get on with the description of Mr. Groves's amplifier, we find that he employs six valves in the amplifier proper and a separate power pack to excite the field of his electro-dynamic speaker.

Of the six valves in the amplifier three are type 6J7G's, all connected as triodes, i.e., screen connected to plate and suppressor to cathode. One of the 6J7G's is employed as a driver and this is shunt fed with transformer coupling into the other two 6J7G's in push pull, driving a pair of 2A3's in push pull with self bias.

The plates of the 2A3's feed into an output transformer (load 5000 ohms plate to plate) connected by a 500 ohm line to a speaker matching transformer.

Mr. Groves considers a large measure of his success is due to the fact that all of the transformers in amplifiers are of the high fidelity type manufactured by Trimax Transformers. The speaker employed in the amplifier is a Rola G12 of standard design except for the high fidelity oversize transformer mentioned above. The field of the G12 is excited to 25 watts from a special power pack. The field resistance of the speaker is 6000 ohms.

The majority of the contestants in the competition used crystal pick-ups and Mr. Groves was no exception. He was a little unlucky, however, as his pick-up developed a fault and he did not discover this until after the preliminary judging.

Circuit Values.

The crystal pick-up is fed through a standard 500,000 ohm potentiometer to the grid of the triode connected 6J7G, the cathode resistor for which is 2000 ohms by-passed

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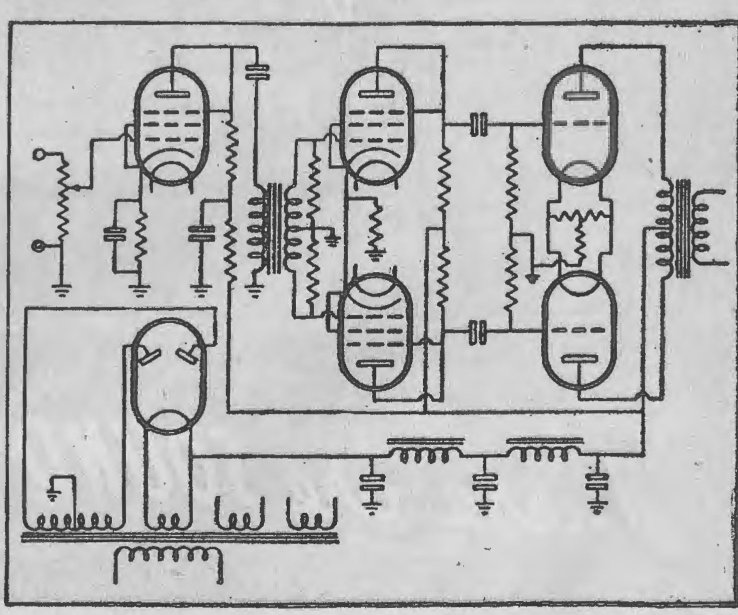

CHAMPIONSHIP (Continued)

with a 25 mfd, electrolytic condenser.

The plate of the J7 is connected through a .5 mfd. coupling condenser to the primary of the high fidelity push pull coupling transformer. The plate feed resistor has a value of 50,000 ohms, whilst the decoupling resistor is 10,000 ohms. The junction of these resistors is by-passed with an 8 mfd. electrolytic.

The grids of the push pull drivers are fed from the secondary of the push pull transformer, each side of which is shunted with a .25 megohm resistor. The cathode resistor for the push pull drivers is 1500 ohms and this unbypassed.

The plate coupling resistors for the push pull drivers are 100,000 ohms each and no decoupling is employed in this stage. The coupling condensers in this stage are .1 mfd., with a 1 meghom resistor from each 2A3 grid to earth. Bias for the 2A3's is provided with a 780 ohm resistor from filament centre tap to earth.

In the power supply filtering is provided by two efficient chokes, the filter having condenser -input from the filament of the rectifier valve. The first choke has an 8 mfd. condenser either side, whilst a lumped capacity of 24 mfd. is connected to the main B positive supply. A 2.5 volt winding for the filaments of the 2A3's and a 6.3 volt winding for the driver valves completes the power pack. The winning amplifier was noticeably free from hum, and this is due no doubt to the very efficient filtering in the power pack, thus the decoupling to the first driver stage, and the fact that the Trimax high fidelity coupling transformer is free from hum pick-up.

Lay-Out.

The layout of the winning unit was perfectly straightforward, with the power supply on the same chassis as the audio section, but kept well away from the input circuits.

So much for the amplifier itself. Mr. Groves tells us he used an infinite type baffle in the first two grades, but scrapped this and employed a flat baffle in the Clun Grade. He used the flat baffle on the winning night also.

Little comment can be made on the design of the winning circuit. It is simple and does not make use of any boosting circuits whatever. The same arrangement has been used many times before and shows just what a small triode amplifier can do providing high quality components are selected for its construction, together with a reliable high fidelity reproducer on an efficient baffle.

AESTHETICS OF REPRODUCTION

HIGH FIDELITY OR JUDICIOUS DISTORTION?

By

H. A. HARTLEY

Reprinted from "Wireless World" England

THE object of this essay is to try to show that that particular branch of electronic gymnastics usually known as "high-fidelity reproduction" has not, by itself, got the value to a trained musician or music lover it is supposed to have, since it falls between the two stools of attempted but unsuccessful imitation on the one hand and spontaneous creative art on the other.

I am fully aware that, in putting forward such a point of view, I am attempting to knock away the foundations of a platform on which I have stood for more years than I care to think of; but I also feel sure that with riper experience one should change one's mind if one feels called on to do so. So I have changed my mind. I am no longer an exponent of plain, unadulterated high-fidelity reproduction. I shall give the reasons why I have changed my mind, and also what technical steps I have taken to achieve what I consider musically satisfying electronically synthesised sound.

The latter phrase is used quite deliberately. A high-fidelity gramophone or radio set does not give a high-fidelity reproduction of a musical composition as performed by an orchestra. The "reproduction" is much lower fidelity than a four-colour process reproduction of an oil-painting. It is not a reproduction at all. What it is shall be deferred for the moment, but I call it electronically synthesised sound, and as the mechanical properties of the loudspeaker have also something to say in the matter, we might shorten the phrase and say just "synethetic sound." The pedant will say, of course, that nearly all sounds are synthetic, but the reader will know what I mean.

What is "High Fidelity?"

I wrote an article in 1932 called "Broadcast Reproduction" ("Wireless World," May 4th and 11th, 1932, pp. 442 and 487). In it I showed that, for reasonably realistic reproduction of speech and music, the frequency response curve of the whole system should be a level straight line between the limits of 32 and 9,000 cycles per second.

The classic experiments of the Bell Telephone Laboratories indicated that the upper limit should be 11,000 cycles per second, and recently Dr. F. G. Dutton ("Recording and Reproduction of Sound," I.E.E., Feb. 15th, 1944) showed that the frequency response range might well go as high as 12,000 c/s.

Schools of Thought

It must be remembered that in the far-off days of 1932 there were two schools of thought bitterly opposed to each other. The one said that the frequency band from 5,000 to 10,000 cycles succeeded in reproducing only interference, noise and scratch, and contributed nothing to the musical quality; the other said that any listener with the slightest pretensions to having a musical ear would at once perceive that a cut-off at 5,000 cycles ruined the reproduction of most musical instruments, all "programme noises" and the human voice. Time proved the "mellow cello" school wrong, but a new controversy arose. Was it better to cut at 5,000 and eliminate scratch and interference, or was it preferable to put up with a noisy background for the sake of good musical quality? There has never been a settlement of this argument, and there never can be, for personal preference enters so completely into the points of view of protagonists in such an argument that it is not amenable to reasoned discussion. "I like what I like" stands completely unassailable.

Musical Taste and Understanding

This business of personal preference is usually known as "taste," and, judged by certain accepted artistic standards, a person may be said to have good taste or bad taste. But it is not all so simple as that. For example, Mr. Eric Coate's "Calling All Workers" is much liked by a very large number of people, but ignored by musicians and music lovers of refined and educated discrimination. This is no slight on Mr. Coates, who professedly writes, and does it very well indeed, what is usually called "light music." But, by the accepted canons of art, a person who likes "Calling All Workers" and dislikes Beethoven's Seventh Symphony is a person of bad musical taste.

Going, now, a stage further, what are you going to say about a person who likes Tchaikovsky's First Piano Concerto, but doesn't like Bliss's Piano Concerto? I think the musical connoisseur would say that anyone who likes the Tchaikovsky Concerto is damned beyond hope, but I think he is much more advanced on the road to good musical appreciation than the person who adores the Warsaw Concerto.

Great or Attractive

There are subtle things in musical composition which finally determine whether a certain work is great or merely superficially attractive. The Warsaw Concerto is pseudo-classical; the Tchaikovsky is not great but it has its points; the Brahms No. 2 Concerto is a great work. Now it is coming to pass that the Bliss Concerto is being regarded as

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REPRODUCTION
(Continued)

a great work, so what can we say about the man who says he likes the Brahms but not the Bliss, and likes the Beethoven Seventh Symphony but not the Bax Third Symphony? It is not a question of taste now, for we are dealing only with musical compositions of undoubted merit. What our friend really means is this: that he understands and appreciates the Beethoven Symphony, but does not understand, and so cannot appreciate, the Bax Symphony.

I hope the reader will now appreciate that I am trying to show the difference between musical taste and musical understanding, for it has a great bearing on "reproduction" of music. Taste divorced from understanding will determine whether you cut off at 5,000 or 10,000 cycles, but what does understanding determine?

Responsibilities of the Scientist

Scientists have recently had an opportunity of trying to thrash this out with a very distinguished musician. Dr. Malcolm Sargent has given his views on "High Fidelity Reproduction" (Brit. I.R.E., March 9th, 1944), and we are at once brought into the realms of art. The scientist may properly object that he has nothing to do with art when he is acting as a scientist, and will probably add that the artist, qua artist, cannot presume to interfere with science. This, unfortunately, must result in stagnation or even worse. All around us we see the result of the scientist allowing his science to be used for purposes he never envisaged when he made his discoveries. I maintain that the scientist should also take an interest in art, for without a social and artistic aim, science becomes abortive. The politician and the artist may ask for something which is scientifically impossible, but if the politician, the artist, the citizen, and the scientist collaborate, something useful will emerge. What can emerge in the field of synthetic sound?

Reproduction is Not Artistic

Dr. Sargent says that what should not emerge is high-fidelity reproduction, in other words, imitation. He maintains, and I am convinced he is right, that imitation cannot be artistic. It will be difficult, at first thought, to appreciate that the nearer you get to reproducing an orchestra playing a certain composition, the further you are getting away from artistic presentation of that work in your own home. Let me illustrate what I mean by reference to reproductions of pictures. An artist in oils will paint a canvas and the result is a work of art. The artist has not only mastered the technique of handling his tools and materials, brushes, knife, pigments, but he has taken care that the composition of the picture is right, that the colours are applied with artistic discretion, and that the way the paint has been put on the canvas is in sympathy with the subject matter of the composition. Now, by photomechanical processes, let us turn out a hundred reproductions of that oil-painting. Those copies are not works of art, they are but imitations of a work of art because the result is not what the artist intended. He designed his painting on the basis of oil pigments on canvas, and the printed reproduction is something totally different both as to materials and surface. On the other hand, an artist may engrave a copper plate, and inked impressions from that copper plate, etchings, are works of art because the artist intended that the technique he used should be the technique of taking inked impressions of his engraving on sheets of paper.

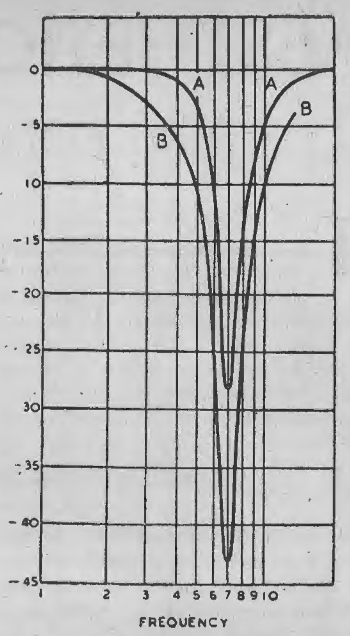

Fig. 2. Response curves of rejector circuit. Frequencies are marked in kilocycles.

Now the scientist may say, "I accept this analogy, and since I am in the position of the colour-printer, I must, like the colour-printer, make my method as faithful as his. I am not an artist; I am concerned only with imitating works of art, and the best I can do is to provide a good imitation." This is logically sound, but is open to objections. I have said that the scientist must be more than a scientist, and Dr.

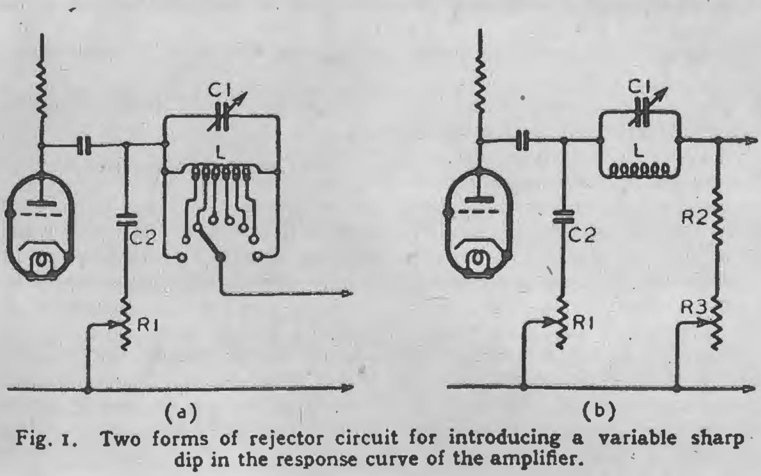

Fig. 1. Two forms of rejector circuit for introducing a variable sharp dip in the response curve of the amplifier.

Sargent says that the musician is not interested in imitations. And since he is not interested in imitations, he is not called upon to answer the question which was put to him at the meeting I referred to, which asked "If perfect reproduction is not scientifically possible. What sort of distortion will the musician object to least?"

Sound to Satisfy

The question we have to ask ourselves is, "What sort of sound synthesis is artistically satisfying?" The answer I propose to give is, "Something other than high-fidelity reproduction." The chief difficulty with high-fidelity reproduction is that it is continually letting you down. You begin to get into the way of thinking that what you have got is pretty well the real thing, and before you know where you are you suddenly become conscience that there is something there which ought not to be there. Whether the intervening medium is a record, film or "the ether," there is a distorting medium which cannot be corrected. With a trained ear and a wide frequency response, distortion of the upper harmonics becomes acutely noticeable, and the more scratch and interference is eliminated by good technique (not by cutting the top) the more noticeable this distortion becomes. It is difficult to see how this form of distortion can ever be overcome. Possibly the best results will be obtained from high-fidelity wired wireless, but what shall we do about our personal libraries on disc and film?

My own experiments have tended to prove that the keenest artistic enjoyment is to be secured when the response curve has been "doctored." I find that the doctoring has to be varied according to the nature of the thing one is listening to, and the doctoring has to be done with a fine sense of artistic dis-

(Continued on next page)

COMPONENT VALUES

L1. 3H. air-cored.
L2. Ordinary RF choke.
L3. Speaker field 1,250 ohm.
L4. 10H. 18 mA.
T1. Special PU transformer.
T2. RF transformer in can.
T3. RF transformer in can.
T4. Bulgin "Senator" transformer 1 to 4 step-up.
T5. Output transformer to give anode-to-anode load of 5,000 ohm.
T6. Mains transformer.
400-0-400V. at 200mA.
5V. centre tapped 2A.
6.3V. centre tapped 2A.
6.3V. centre tapped 2A.
V 1. 6J5.
V 2. 6J5.
V 3. 6K7.
V 4. 6J5.
V 5. 6J5.
V 6. 6J5.
V 7. 6L6.
V 8. 6L6.
V 9. 5Z4.
V10. 5Z4.

Ohms.

R 1. 250,000.
R 2. 10,000.
R 3. 40,000.
R 4. 3,000.
R 5. 250,000.
R 6. 15,000.
R 7. 2 M.
R 8. 10,000.

Ohms.

R 9. 40,000.
R10. 3,000.
R11. 100,000.
R12. 25,000.
R13. 300.
R14. 60,000.
R15. 10,000.
R16. 10,000.
R17. 5,000.
R18. 50,000.
R19. 500,000.
R20. 500,000.
R21. 1,500.
R22. 10,000.
R23. 40,000.
R24. 40,000.
R25. 10,000.
R26. 100,000
R27. 10,000.
R28. 10,000.
R29. 100,000.
R30. 125.
R31. 90,000.
R32. 90,000.
C 1. 50uF, 12V.
C 2. 0.25uF.
C 3. 8uF. 350V.
C 4. 0.05uF.
C 5. 50uF. 12V.
C 6. 0.5uF.
C 7. 8uF. 350V.
C 8. 0.02uF.
C 9. 0.0005uF.
C10. 0.0005uF.
C11. 0.1uF
C12. 0.1uF.
C13. 0.1uF.
C14. 0.0005uF.
C15. 0.0003uF.
C16. 0.0003uF.
C17. 8uF. 350V.
C18. 8uF. 350V.
C19. 0.25uF.
C20. 0.25uF.
C21. 8uF. 350V.
C22. 0.25uF.
C23. 0.25uF.
C24. 8uF. 350V.
C25 and C26 are each 2-32 uF 350V. wet electrolytics in series, giving 16 uF at 700V.

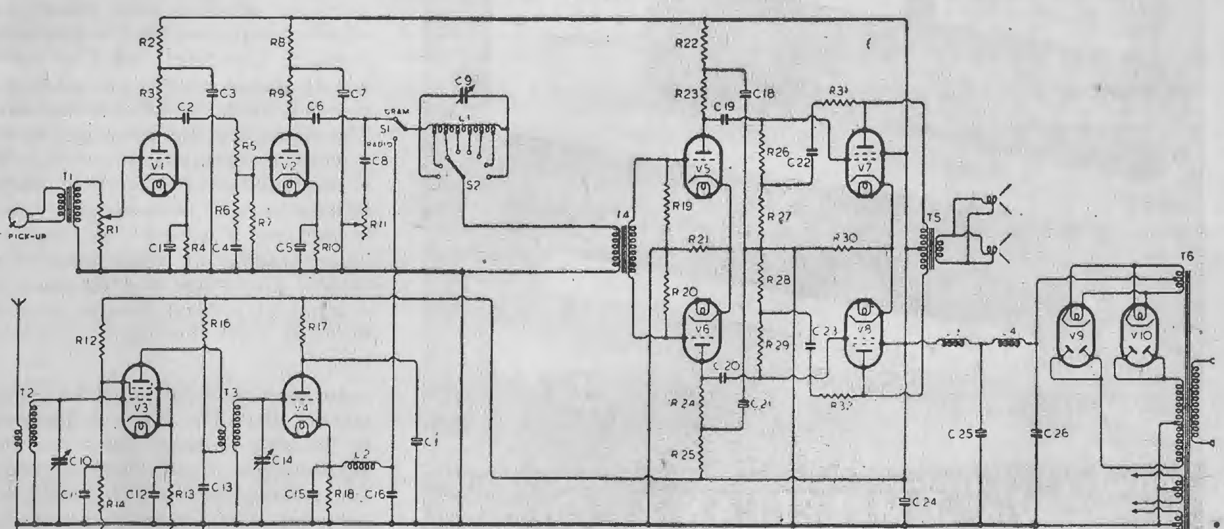

Fig. 3. Circuit diagram of complete radio gramophone. Component values are given in the table.

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(Continued)

cretion. Putting it briefly, I start off with a high-fidelity radiogram, and then, according to my mood and the mood of my fellow listeners, I do certain things to the electrical and acoustic properties of the apparatus, so that what issues from the loudspeaker is artistically satisfying. All this is perfectly legitimate. I did not design my radiogram merely to be able to show a fellow technician that I was capable of producing a technical marvel; I designed it so that I should get pleasure and satisfaction from listening to the music, the synthetic sound it made. The instrument and the control knobs were my brushes and pigments, and the room was my canvas. I have found, as have my friends, that there is far more emotional "kick" to be got from the result than I ever got from straight high-fidelity reproduction, so called.

Now this means that my musical taste as well as my musical understanding has been imposed on the sound; but in saying this I hope a misunderstanding will not arise. If, as a designer, I included a top cut-off at 5,000 cycles per second, then those who used instruments made to my design would have my taste interfering with their taste. If I provided a "high-fidelity" instrument without control knobs, then the individual listener could not gratify his desires. So I must provide a number of knobs which can alter the response curve in various ways, but the original curve must be as wide and flat as possible. Thus the listener is able to gratify his taste and his musical understanding.

Mellow Tone

His taste is satisfied by his choice of broadcast programmes and records, and by his freedom to choose between "mellowness" and "high-fidelity." His understanding is satisfied in a more subtle way. What he is listening to is not the sound that was produced in the studio, nor may it be what the composer intended he should hear. It is something quite different, and different in colour or texture but not in form. Dr. Sargent pointed out that a great artist could take liberties with Beethoven; but if you are not a great artist then it is better to play straight Beethoven. A listener to reproduced music cannot interfere with the form of a Beethoven composition, but as its colour or texture has already been interfered with before it reaches the listener's room, further interference is justified if the final result is more acceptable to a discriminating ear. The nature of that further interference is determined by musical understanding of what was likely to have been in the composer's mind in the first place, and, in addition, understanding of what constitutes artistic knowledge and creation of a series of musical sounds, even if different from the original conception.

In parentheses, it might be pointed out that Dr. Sargent believed in the idea of composing music for reproduction by electrical methods, for entirely new effects could be achieved which were impossible in a concert hall. This does not imply the use of electronic musical instruments, but that individual instruments can be given a power not possible under purely acoustic conditions. With this sort of composition a knobless reproducer of predetermined specification is essential. The composer is using known materials to achieve a certain artistic result.

The Sorts of Distortion to be Avoided

In a technical sense, this doctoring of the response curve means distorting the response curve, and where we are adding distortion to distortion already present (since anything less than absolutely perfect reproduction must contain distortion) we must be careful not to introduce distortion which will offend a sensitive musical ear. Some of the things that must be avoided at all costs are cabinet resonances, air column resonances in the cabinet, noticeable resonances in the speaker and pick-up, valve overload, bass and treble attenuation,. The resonant types of distortion are very distressing. Pseudo-bass from a cabinet or speaker becomes a one-note thump which accompanies all music. The customary 3,000-cycle resonance in a poorly designed speaker does not give brilliance to the reproduction but merely "edge," which becomes extremely fatiguing and does not allow one to "turn the wick up" when it is felt that this is necessary. Absence of real bass takes the body out of the music; absence of top deprives the musical instrument of its characteristic quality, and orchestral works become muddy, indeterminate noises lacking depth and clarity and any musical value. Valve overload gives rise to very unpleasant harmonic distortion, which, however acceptable it may be in a factory broadcasting system, is unbearable in a home musical performance for discriminating listeners.

It will have been noted that resonances, which mean excessive output at some particular frequency, are to be avoided; they must also be avoided for another reason. The surface noise, or scratch, from a gramophone record is reproduced with great intensity when there are well-marked resonances in the speaker or pick-up; it is almost innocuous when the overall response is flat, even when there is no top cut-off below, say, 10,000 cycles per second. It will be seen, therefore, that scratch is not to be elminated by cutting top, for if the speaker resonance is at 3,000 cycles the cut would have to be below this, and the musical quality resulting from such a cut would be valueless. Scratch can only be subdued by having an overall response in which there is no output peak due to resonances.

The Sort of Distortion that is Needed

So far, then, I have postulated that resonances must not be present, that there must be neither bass nor treble cut, that there must be no harmonic distortion due to valve overload. This seems to be a specification for high-fidelity reproduction, and so it is. Where, then, does the "doctoring" come in? The answer is to put depressions in the response curve, their width and depth depending on the effects to be achieved. I have found, by comprehensive experimenting over a long period, particularly on records, that while the ear is acutely sensitive to peaks on the response curve it does not appear to notice the presence of valleys, or, at any rate, of canyons and gorges. If, however, these canyons and gorges can be introduced in certain variable ways, for the ways must be variable according to the effect desired, a good deal of the noticeable imperfections in musical reproduction can be taken out without in any way spoiling the musical quality of the instruments. Quite obviously a response curve with canyons must introduce amplitude distortion which does not exist in a flat response, but the result is more artistic, and lines up with Dr. Sargent's contentions that truth is not necessarily beauty, that high-fidelity is to be avoided if you want to be artistic, that beauty begins where utility ends.

Practical Considerations

I shall give a description of the apparatus I have used for the tests

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which led me to adopt the opinions I now hold, but as this might be described as the technical part of my article, I may conveniently give here a short explanation of how the introduction of a canyon in the response curve can suppress (or rather, not allow to be created) unpleasant and unmusical noises. It would become very complex and difficult to deal with the whole gamut of musical sounds played simultaneously by a large orchestra, just as difficult as trying to give equations showing how the single diaphragm of a loudspeaker can make a noise like an orchestra. A simpler example can be discussed —surface noise with records.

Scratch

I have pointed out that surface noise is likely to become very noticeable and strident if there is a peak in the speaker or the pick-up (I assume that linear amplifiers are not difficult to make). It can be shown, too, that in the absence of peaks or resonances the surface noise is not particularly prominent. The former effect is due, in large part, to the fact that a loud note emitted as a fundamental by the peak, modulated as it were by the surface noise, will create new upper harmonics if sufficiently intense, and new subjective tones, either summational or differential, with other tones already present in the reproduction (see any standard textbook on sound). With a flat response equipment, I have also noticed that the comparatively gentle hiss of surface noise appears to form subjective tones with other tones present in the reproduction, and it seems reasonable to suppose that these new spurious tones are the cause of what a keen ear usually puts down as harmonic distortion in high-fidelity reproduction. What happens is that new harmonics are added to the harmonic range of the musical instruments, and the musical artist at once says there is something wrong.

Surface noise, if not exactly "aperiodic," like atmospherics in radio reception, is present over a large part of the frequency spectrum. The more critical part is between 2,000 and 8,000 cycles per second; but if we suppressed all harmonics we should also suppress the wanted music. The more prominent interferences can be located and suppressed by moving our deep canyon up and down the frequency scale. At a certain point the surface noise will drop suddenly, and the extreme treble will instantly become cleaner. This point is not the same with all records nor even with records of the same make; it can only be found by trial, and it is an interesting experience to notice how the character of the surface noise changes as one or another harmonic is suppressed. Finding the best setting is part of the art of sound synthesising in the home.

The Rejector Circuit

The simplest way of injecting a sharp dip into the response curve is by using a rejector circuit. Fig. 1 shows two forms. The tuned circuit L C_1 must be fairly low-loss, and this is not too easy to achieve since the inductance of L is appreciable. C_1 can be a 0.0005 uF

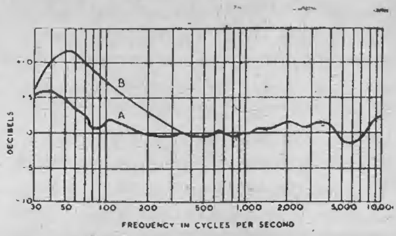

Fig. 4. Response curves of pick-up and amplifier: Curve A, amplifier with restricted negative feedback in the bass; Curve B, amplifier with tone-correcting stage.

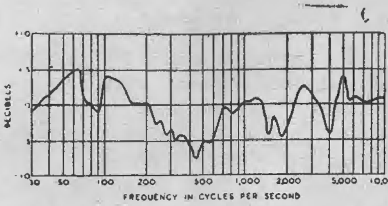

Fig 5 Response curve of pick-up, amplifier and speaker

variable air-dielectric condenser, and L should have an inductance of 2.5 to 3 henries and be air-cored. It is possible that a suitable design could be worked out with high-permeability core material, but I have not actually made such an inductor. The coil should be section-wound to keep down self-capacity and the wire should not be finer than 36 SWG. As several tappings are required (six spaced equally throughout the coil) it is probable that trouble would be experienced in bringing these tappings out of the condensed winding of a high-permeability design.

Coil Details

Fig. 1(a) shows the better arrangement. An eight-way switch is connected to the two ends and six taps of the coil, and the variable condenser across the whole of the coil. The fixed vanes should be connected to that end nearest the previous valve anode coupling condenser. When the switch arm is connected to the first tap of the coil, the rejector circuit will cause a very sharp dip of about 28 db. to appear in the response curve of the amplifier, as shown in Fig. 2, curve A, where the point of maximum attenuation is shown at 7 kc/s. By adjusting C_1 this point can be moved (with a 3 henry coil) over the range 4 to 10 kc/s. When the switch arm is connected to the free end of the tuned circuit, the dip will be like curve B in Fig. 2. If the reader happens to possess a suitable coil which is not tapped, it can be connected as in Fig. 1(b), where R_2 can be 5,000 to 10,000 ohms and R_3 is a variable resistor of 100,000 ohms. The arrangement of Fig. 1(b) is infinitely variable, of course, but I have found it convenient to have the adjustment in steps, as it is usual to find that a certain record requires one particular tap, and it is a simple matter to mark each record with the number of its best tap. The rejector circuit is put out of use by moving the switch to the beginning of the coil.

For Worn Records

The top-cutting circuit C_2R_1 is never used except with old or worn records and for special effects. C_2 should be 0.02 uF and R_1 100,000 ohms. With R_1 at maximum, the effect of the circuit is negligible; with R_1 at minimum resistance the loss of top is severe. It is amusing to use this top-cutting circuit with organ records on which there is little or no playing on reed pipes. The flute stops of the organ have a limited harmonic development and are not spoiled by loss of top, but with reduced top and increased volume the pedal bass can be reproduced in a manner which is thrilling, provided the speaker can stand it without overloading.

Two rejector circuits in series might be used, to give two sharp dips in the response curve. A greater measure of conductorship could thus be applied to the music, but great care would have to be exercised, for if the two rejectors were tuned to fairly closely adjacent frequencies something like an inverted band-pass circuit would result, with distressing consequences from a musical point of view. One rejector circuit will be found adequate for ordinary requirements.

With practice, handling the rejector circuit control becomes quite easy. It is used in conjunction with the volume control and the top-cutting-off control (I cannot bring myself to using the expression "tone control") when the latter has to be used. The volume control is used, of course, to increase contrast, since the volume range on both radio and record is much restricted. Automatic contrast expansion just will not work because it cannot divine what is going to happen next. Detailed knowledge of what is on your records will enable you to do all the expanding you want, and with very artistic results, if done properly; but you cannot do anything about B.B.C. broadcasts. The only way to control their control engineer is to bludgeon him into insensibility. If the controls are going to be used continuously in this way, then provision should be made for getting them outside the cabinet, to keep pick-up chatter within its proper bounds. I have found flexible drives of the Bowden cable type, which can be pushed back into the cabinet, very convenient for this purpose.

The circuit of the complete instrument is shown in Fig. 3. The switch S1 provides the change-over from radio to gramophone. The radio receiver is a simple TRF and detector circuit with manually controlled RF gain. As there is no volume control on the main amplifier, R15 is the only controller of volume on radio. This calls for a

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detector which is free from distortion on widely different RF inputs, and the conditions are fulfilled by the so-called infinite impedance or negative feed-back detector. This type of detector has the additional advantage of imposing little damping on the tuned circuit preceding it, and adequate selectivity can be obtained from only two tuned circuits, one of which, the grid circuit of V1, is heavily damped by the aerial. C10 and C14 are, of course, ganged. T2 and T3 are identical and are the usual RF transformers. No wave-band switching is provided, and if there are long-wave windings on the transformers and they are not going to be used, they should be short-circuited. Nowadays, it is rather a waste of time to try to perfect the radio receiver, as so many of the B.B.C. programmes consist of home-made recordings of execrable quality compared with direct studio transmissions. However, the simple arrangement shown gave excellent results in pre-war days. It will, no doubt, be appreciated that the rejector circuit L1L9 can be used to suppress heterodyne whistles.

Tone Control: Bass Compensation

The gramophone tone-control amplifier, which includes V1 and V2 is quite interesting. I have tried almost every arrangement of tone controlling that has been published, and find it impossible to recommend any circuit which includes inductances. There is no cheap way out of the problem, and tuned resonant circuits in tone-control stages, used as boosters, introduce the very defects we are trying to eliminate. We must compensate for the reduced amplitude of bass frequencies on standard records, and the only satisfactory way of doing this is to waste the middle and top somewhere and push up the over-all amplification. The network R5R6C4R7 reduces the middle and upper frequencies gradually and to such an extent that the increased amplification provided by V1 (or V2) gives, in effect, the requisite bass increase, 6db. per octave, with the values quoted. A very good exposition on tone control is given in F. Langford Smith's "Radio Designer's Handbook."

Pick-ups

The pick-up is one of the most critical components in the whole outfit. The usual heavy types with a needle pressure of about 120 gm. are quite unsuitable for serious work, and the type of pick-up which gives a large output in the bass by virtue of tone arm resonance (and therefore has excessive needle point reactance) will make a steel needle plough its way through the groove of a deeply modulated record, or knock the point off a fibre needle. By hook or by crook the reader should try to get one of the light-weight sort, using miniature needles or a jewelled stylus. I use the H.M.V. "Hyper-sensitive" needle armature type. This pick-up has a very low impedance, and requires a high-ratio step-up transformer, T1. Actually, the present arrangement has more gain than is absolutely necessary, and it is possible that the output of V1 might be adequate with the pick-up connected directly across R1. Every precaution must be taken to avoid introducing hum into the grid circuit of V9, and T1 should be enclosed in a mu-metal box; if this is not obtainable and an ordinary steel box has to be used, the transformer should be carefully orientated into the position of minimum hum pick-up. The motor winding and the mains transformer are the usual

COURSE IN ELECTRO-ACOUSTICS

Next year, for the first time in Victoria, there will be a class in electro-acoustics. This class will be held one night each week in the Physics School of Melbourne Technical College. The course is a professional one and will include demonstrations and practical work on vibratory motion, loudspeakers, pick-ups and microphones. Students will have opportunities for testing their own equipment.

MUSIC WHILE YOU WORK

Following an investigation of the effect of music in relation to repetitive manual work the American War Production Board has issued some interesting findings which are based on the result of a survey covering 100 war plants in all parts of the United States. Of the plants visited 76 were using recorded programmes for their music sessions whilst the remaining 24 employed either bands or orchestras mainly recruited from the staff. It should perhaps be pointed out that there are no broadcast programmes similar to the B.B.C.'s "Music while you work" shows transmitted in the United States.

Effect on Morale

Considerable space in the report is devoted to the effect of music on morale, production, etc., and to the length and frequency of programmes, but we will confine ourselves to a few technical findings.

It is stated that given efficient technical equipment and enough loudspeakers music was found to be perfectly audible to workers even above a noise level of 100 decibels, or more. The explanation is said to be that the ears of workers become attuned to the noise in which they work and which actually forms for them a background to the music.

Level Must Be Constant

The importance of maintaining the volume at a constant level is stressed, and to this end it is recommended that special recordings for reproduction in works should be made. Until such times as these are available in sufficient quantity the inclusion of a volume expander in the amplifier is recommended.

In many cases programmes were being relayed over PA systems originally installed for paging people through the works. These were, of course, found to be unsuitable as they are not designed for the wide frequency coverage necessary to reproduce music.

sources of induced hum. For some obscure reason many gramophone motors fitted on unit plates with automatic brakes are so arranged that the motor field (and commutator is just below the pick-up when it is resting on the record. A low impedance pick-up under these conditions will give very bad hum. The cure is to turn the motor through 180 degrees in a horizontal plane. The automatic brake should be set so that it trips only on the run-off. Sideways pressure on the needle while playing is fatal to good results.

The H.M.V. pick-up can develop a defect peculiar to itself. The small needle is not held by a screw, but rests in two V grooves opposed to each other, at the top and bottom of the armature proper. If the needle is too slack when in position it will rattle on loud passages, causing a distressing buzz in the music. The armature should grip the needle so tightly that it can only be changed by using a small pair of pliers. If the needle is slack, the top of the armature should be squeezed gently until the end of the seedle fits tightly.

Types of Needles

There can be no doubt that a diamond or sapphire stylus is the best needle. A chromium-plated needle becomes almost useless, from a musical quality point of view, after about ten 12-inch sides, in spite of the claims in the advertisements; the wear is clearly discernible even with a low-power magnifying glass. Fibre needles are a snare and a delusion. Not only is it impossible to get any "top" with fibres, but they ruin good records through excessive wear of the records. It is impossible to get all the dust out of the grooves, and what is left gets embedded in the needle, converting it into a first-class abrading instrument. Ideally, the friction between the needle and the record should be non-existent, and the nearest approach to this is reached by a well polished jewel. A jewelled stylus in an undamped pick-up causes negligible record wear.

The Main Amplifier

The main amplifier is fairly conventional. Phase splitting is done by a small mu-metal cored transformer, the secondary being loaded with the two equal resistors, R19 and R20, which also provide the centretap. The transformer could drive the output stage and save V5 or V6, but I have a pet theory that small transformers of this type should not be called on to handle large AF voltages. A phase-splitting valve could be used but seems unnecessary.

The output stage consists of two 6L6 tetrodes in Class A. With 250 volts on anodes and screens they will give 14 watts AF output with an anode-to-anode load of 5000 ohms. With a reasonably sensitive speaker this is as much as can be borne in a medium-sized room. Negative feed-back is applied across the output stage. The push-pull arrangement looks after second harmonic distortion, and negative feed-back takes care of the third harmonic. Feed-back also improves the electrical damping on the speaker and makes the valves behave more like triodes. The feed-back condensers, C22 and C23, are normally 0.25 uF; if reduced to about 0.05 uF a rise of about 6db. will occur at the lower end of the response curve, as shown in Fig. 4, curve A. This rise is useful in helping to correct the "finiteness" of the speaker baffle without losing the benefits of feed-back in the treble where it is most needed. Fig. 4, curve B, shows the over-all response of pick-up, tone-correcting amplifier and main amplifier, the circuit being given in Fig. 3. It should be realised that the speaker may be damaged with large inputs, unless the diaphragm-voice coil assembly is freely mounted with a permissible excursion of about ⅜in.

Frequency Response

These curves were taken by measuring volts on the output transformer secondary, the speaker being connected, when the pick-up was laid on a set of constant frequency records. The usual corrections were made from the information given on the record labels and the curves plotted. A check was then made on a gliding tone record, and the output was found to be substantially constant at all frequencies. The rejector circuit was out of action when the curves were taken.

"JUNGLE-PROOF" SETS

The maintenance of radio equipment in the severe climatic conditions in the Pacific Islands and Burma presented a problem to designers which, according to a report in the "New Zealand Standard," has been successfully tackled by New Zealand technicians, who have produced a set which is "jungle proof."

Every component liable to be affected by heat or moisture is coated with a protective film of wax or petroleum jelly. The set was subjected for six hours to a temperature of 140 deg. F. at a humidity of 100 per cent.—a combination in which no human being could live—and still functioned.

The complete transmitter-receiver, although designed for use in armoured vehicles, can be carried by two infantrymen.

The response of the complete equipment from pick-up needle to actual sound output is shown in Fig. 5. The decibel scale has been exaggerated to make the curve look as bad as possible, yet it is not a bad curve. With one small exception of a narrow dip at 450 cycles, it falls within the generally recognised limits of ± 5 db. for minimum perceptible change of output level. The valley from 70 to 90 cycles, if it really exists, is probably due to some peculiarity of layout inside the cabinet.

The Loudspeaker

The speaker is a new unit of my own design not yet placed on the market. The energised field is represented in Fig. 3 by L3 and has a resistance of 1,250 ohms, dissipating 40 watts. The field-magnet gap is quite small, and this gives a very intense field in the gap, absolutely essential for good transient reproduction. The speaker is mounted on a very small baffle-board which is then tilted, completely insulated by sponge rubber and held by a framework against the front of the cabinet. This entirely eliminates

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acoustic feedback through the turntable.

The cabinet is constructed of walnut-faced 1in. thick block board lined with half-inch wallboard. The various parts of the equipment are irregularly disposed in the cabinet, and there is absolutely no trace of bass resonances due either to speaker, cabinet or air-column. The dip at 70 cycles, already referred to, is not perceptible.

Twin Speakers

The two speakers shown in Fig. 3 are of identical design. The second was added when it was found that the music was unbalanced in certain parts of the room. The cabinet speaker is near the floor, and the best place for the other was found to be near the ceiling, tilted downwards, and in a corner 90 degrees away from the corner where the cabinet stood. The improvement in depth and realism was very great. A battery of specialised speakers might be better, but the very greatest care has to be taken to get the right cross-over point between treble and bass speakers. If properly done, it is likely to prove too costly for domestic use. If carried out in a slipshod way, with speakers of indifferent performance, the results are usually atrocious.

The listening room has a thick carpet, thick curtains, the usual "three-piece" type of easy chairs, books lining the walls up to a height of about three feet, and the upper parts of the walls left fairly highly reflective. Some reflection is needed.

Envoi

I am afraid I cannot tell the whole story here; the subject is too vast. I have tried to make it clear that the scientist just cannot design, say, a radiogram, hand it over to the factory to produce, and then let the sales department plug the product without some regard for its æsthetic possibilities. If a manufacturer is concerned only with making money, then there is nothing more to be said. But if he is also trying to appeal to the artistic senses of his customers, he cannot get away with selling a high-fidelity instrument and leaving it to take care of itself, for the musician, as explained by Dr. Sargent, will have none of it. Nor, if it comes to that, will he take the ordinary low-fidelity instrument as anything more than a sort of noise box that emits news bulletins at specified times. Something has got to be done for the musically minded listener; and as the musician has not got the skill to produce what he wants, the scientist must add artistic sensibility to his technical accomplishments.

In a crude sort of way I have made a first contribution to this new concept of home music via broadcasting, records and an electrical device in the home itself. Others will do much better than I have been able to do when they realise that better will have to be done if "electronically synthesised music" is to take its place among the arts. Apart from the receiving side, a great deal will also have to be done at the studio end, but on that aspect I have no space to write.

If any of my readers can construct a radiogram such as I have described, and care to acquire the art of distorting the response curve to gain artistic ends, they will, if they love the art of music, find new pleasure, not in making imperfect copies of the original performance, but in creating music of their own. It is not given to all of us to be able to make music with musical instruments, but we can try and make music out of the raw material which we can tap when we like, the raw material of records and broadcasting. here is no art in sitting passively while a machine churns our music out for us. We must be up and doing for ourselves.

POST-WAR DEVELOPMENTS

Possibilities of after-war developments in film reproduction of sound with new emulsions having improved resolution were indicated as being on the way. A frequency range even exceeding 15,000 or 16,000 cycles was mentioned in this connection.

An interesting story was told of the manner in which some of the early difficulties with processing films had been overcome, especially in regard to taking copies of the negatives owing to shrinkage during development.

Although some people doubted the necessity of raising the frequency range to 12,000 cycles, the opposite view prevailed that it is essential to take the frequency range as high as possible for an adequate reproduction of music, particularly in securing fidelity of "attack."

RECORDS ON WIRE

The electronic wire recorder is now in mass production by the General Electric Co. under license from the Armour Research Foundation. The wire recorder has many wartime uses, important among them being its employment in observation planes. Instead of using the usual pad and pencils the pilot dictates directly into a microphone and his words are recorded magnetically on the wire, which is 0.004 inch in diameter. When there is no further use for a recording the speech can be "wiped off" magnetically and the wire re-used for future recordings. On the other hand, 100,000 reproductions of one recording have failed to alter its quality in any respect. Sixty-six minutes of continuous speech can be recorded on 11,500 feet of the hair-like wire, wound on a spool no larger than a doughnut.

Invasion Story

The wire recorder was used in producing a permanent record of the invasion by the Marines of Empress Augusta Bay on Bougainville. A descriptive account of the air and naval bombardment was made by Sgt. Roy Maypole, Marine Corps radio reporter, from the deck of a transport a short distance off-shore. When the Marines landed Sgt. Maypole went with them, lugging his recording equipment into the thick of the battle.

Allied and Neutral Countries Short-Wave Schedules

These schedules which have been compiled from listeners' reports, my own observations, and the acknowledged help of "Universalite" and "Victory News," are believed to be correct at tme of going to press, but are subject to change without notice. Readers will show a grateful consideration for others if they will notify me of any alterations. Please send reports to: L. J. Keast, 23 Honiton Ave. W., Carlingford. Urgent reports, 'phone Epping 2511.

Loggings are shown under "Short Wave Notes and Observations." Symbols: N—New stations; S—Change of Schedule; F—Change of frequency; X—See Short-wave Notes.

Call Sign Location Mc. M. Time: East. Australian Stand'd

GVR, London—21.67 N 13.84—7-10.15 pm.
GSH, London—21.47 S 13.97—9.45 pm-1.30 am.
WVLC, Leyte—18.60 N 16.14—Irreg. Around 8 and 9.30 am.
WCRC, New York—18.16 N 16.52—Around 12.15 am.
WNRX, New York—18.16 N 16.52—Closes 7.15 am.
GVO, London—18.08 16.59—9-10 pm.
AFHQ, Algiers—18.02 16.64
GRO, London—18.02 '16.64
WLWR, C'nnati—17.96 N 16.70—Around 3 am.
XBC, D. New Guinea—17.91 N 16.75—Irreg. 9 am.
GEX, New York—17.89 N 16.77—Around 5.45 am.
RP, London—17.87 S 7-11.45 p.m.; 1.30-3.45 a.m. 16.79.
IRE, Athlone—17.84 16.82—3.30-4 am.
VUD-5, Delhi—17.83 N 16.83
WCDA, New York—17.83 16.83—Idle
WCRC, New York—17.83 16.83—Idle
WCBN, New York—17.83 N 16.83—10.15 pm-9 am
GSV, London—17.81 S 16.84—5 pm-1.15 am
VLI-8, Sydney—17.80 16.85—Idle
WLWO, C'nnati—17.80 16.85—7.30-8.45 am; 10 pm-4.30 am.
GSG, London—17.79 S 16.86—9-10.30 pm.
WRCA, New York—17.78 16.87—11 pm-2.45 am
WNBI, New York—17.78 16.87—7.30-8.45 am
OPL, Leopoldville—17.79 16.88—4.55-6.15 am
KWID, 'Frisco—17.76 N 16.89—6-9.45 am
KROJ, 'Frisco—17.76 16.89—11 am-1.45 pm
WRUW, Boston—17.75 16.90—9.30-11.15 am; 12.15 am-4.30 am
WVLC, Leyte—17.74 N 16.91—Irreg.
GVQ, London—17.73 16.92—9.30 pm-1.15 am
LRA-5, B'nos Aires—17.72 16.93
——, B'ville—17.71 16.94—6.30-7 am
GRA, London—17.71 16.94
GVP, London—17.70 N 16.95—8.45-9 pm.
HVJ, Vatican City—17.445 N 17.20—Around 12.15 am
KMI, 'Frisco—17.09 17.5—Irreg.
WCW, New York—15.85 18.93
LSL-3, B. Aires—15.81 18.97
——, Moscow—15.75 S 19.05—8.47 am-Noon; 9.20-11.30 pm; 2-3 am.
FZI, B'ville—15.59 S 19.25—4.30-10.45 pm
RNB, L'ville—15.53 19.33—9-11 pm
KR, Bolinas—15.46 19.4—Irreg. around noon.
RD, London—15.45 S 19.43—1.30-5.15 am.
GWE, London—15.43 S 19.44—3.45 pm-1.15 am
GWD, London—15.42 19.46—S 6.45-8 pm
——, Moscow—15.40 F 19.47—See 19.51.
RE, London—15.37 19.51
——, Moscow—15.37 S 19.51
KWU, 'Frisco—15.35 19.53—9.45-11.30 am.
VUD-3, Delhi—15.35 19.54
WRUL, Boston—15.35 S 19.54—M/N-3.30 am; 3.45-4.30 am
WRUW, Boston S—15.34 S 19.54—4.45-8 am; 8.15-9.15 am
WGEO, S'tady—15.33 S 19.57—5.45-7.15 am; 9-11.15 pm; 11.30 pm-5.30 am.
KGEX, Frisco—15.33 19.57—8.15 am-3 pm.
KGEI, 'Frisco—15.33 19.57—Idle
VLI-3, Sydney—15.32 S 19.58—Idle
VLC-4, Shep'ton—15.31 S 19.59—8.30-10.15 am; 11.45 am-12.45 pm.
GSP, London—15.31 S 19.60—4-6 pm; 9-10 pm; 1-1.45 am; 2-2.15 am
KGEX, 'Frisco—15.29 N 19.62—2-6.55 am
KGEI, 'Frisco—15.29 N 19.62—7 am-3 pm
VUD-3, Delhi—15.29 19.62—1-7.30 pm; 9.30-11 pm
S.E.A.C., Colombo—15.27 N 19.64—1-3.30 pm
WCBX, New York—15.27 S 19.64—9 pm-6.45 am.
GSI, London—15.26 19.66—1.30-7 am.
XBCD, New Guinea—15.26 N 19.66—Irreg.
WLWK, C'nnati—15.25 19.67—7.30-10.15 am; 10.15 pm-7.15 am
WLWL, C'nnati—15.23 N 19.69—7-10 am; 8-11.45 pm; M/N-12.30 am; 12.45-3.15 am.
VLG-6, Melbourne—15.23 S 19.69—1-1.25 pm
——, Moscow—15.22 19.70—7.15-7.40 am; 8.47-9.30 am; 11.15-11.40 am—9.40-10.20 pm
WBOS, Boston—15.21 S 19.72—7.30-10.15 am; 9.45 pm-7.15 am

Call Sign Location Mc. M. Time: East. Australian Stand'd

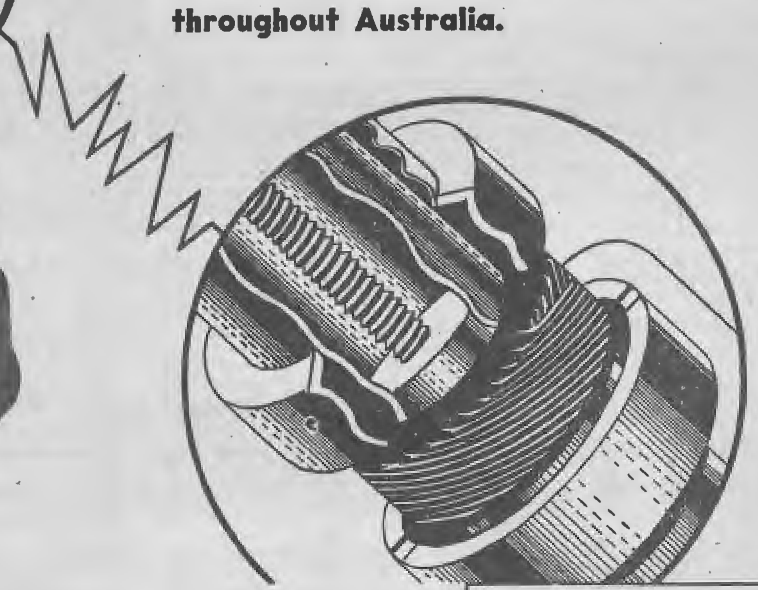
XGOY, C. King—15.20 19.73—Irreg.
WLWL-1, C'nnati—15.20 N 19.73—8-11.45 pm; M/N-12.30 am.
TAQ, Ankara—15.19 19.75—7.30-10.15 pm
VUD-5, Delhi—15.19 N 19.75—8 pm
KROJ, 'Frisco—15.19 S 19.75—2-4.45 am; 5-6.45 am; 7-10.45 am
WOOC, New York—15.19 S 19.75—9.45 pm-7 am
WKRX, New York—15.19 S 19.75—Think now idle
XGOX, Chungking—15.18 19.76—Wed. only 10-10.45.
GSO, London—15.18 S 19.76—2-6.30 am; 4-6 pm; 10.30 pm-1.45 am.
OPL, Leopoldville—15.17 N 19.78—Around 9 pm.
TGWA, Guatemala—15.17 19.78—3.45-4.55 am (Mon. till 8.15)
VLG-7, Melb.—15.6 19.79—6-8.10 am (Sun. from 6.45)
SBT, Stockholm—15.15 19.80—1-4.15 am; News, 10.01 am
WNBI, New York—15.15 S 19.81—9.45 pm-5.30 am.
WRCA, New York—15.15 S 19.81—7-9.45 am.
GSF, London—15.14 S 19.82—3-6 pm; 7 pm-1.15 am
KGEI, 'Frisco—15 13 S 19.83—6-8.30 pm
WRUS, Boston—15.13 S 19.83—6.45-8 am; 9.45 pm-3.30 am; 3.45-6.30 am.
HVJ, Vatican C—15.12 19.84—Irreg. in afternoons
——, Moscow—15.11 19.85—P/I with 19.70 met.
GWC, London—15.07 S 19.91—5.30-6.30 pm; 8.15 pm-6.45 am
GWG, London—15.06 19.92—No schedule
——, London—15.01 N 19.98—See "New Stations"
WWV, Washington—15.00 20.00—Frequency check.
PSE, Rio de Janiero—14.93 20.07—Not heard recently
WVLC, Leyte—14.85 N 20.20—Irregular.
XBC, New Guinea—14.80 N 20.27—Irreg.
VUD-, Delhi—14.57 N 20.58—Irreg. in mornings
WNRX, New York—14.55 N 20.61—Heard around 7.45 am and 9.30 pm
——, Moscow—13.42 22.35—Irreg. around 10.45 pm
WNRI, New York—13.05 N 22.98—7-9 am; 9 pm-M/N
WLWL, C'nnati—13.022 N 23.03—8 p.m.-
——, Moscow—12.99 N 23.09—7.30-10.20 pm
WLWR, C'nnati—12.96 N 23.13—Heard closing 8.45 am; 8-10 pm
WKRD, New York—12.96 23.13
HER-, Berne—12.96 S 23.14—Tues. & Sats., 6-7.30 pm
CNR, Rabat—12.83 23.38—8-9.15 pm
XBC, New Guinea—12.65 N 23.72—Irreg. during day and night.
HCJB, Quito—12.44 24.08—6 am-1.15 pm; 9.55 pm-M/N
——, Moscow—12.26 24.47—3-9 pm
TFJ, Reykjavik—12.23 24.54
——, Moscow—12.19 24.61
——, Moscow—12.17 24.65
R. France, Algiers—12.12 S 24.75—8-8.15 pm
ZNR, Aden—12.11 24.77—2.45-8.15 am
GRF, London—12.09 S 24.80—5 pm-3.45 am
GRV, London—12.04 S 24.92—8 am-1.30 pm; 3.45-8 pm; 9-9.30 pm; 1-1.45 am; 2-4.15 am
CE-1180, Santiago—11.99 25.01—8 am-2 pm
FZI, B'ville—11.97 S 25.06—3-4.30 pm; 2-10.55 am
HER-5, Berne—11.96 N 25.08—Idle at present
Tbilisi, Tiflis—11.96 25.08
GVY, London—11.95 S 25.09; 8 pm-3.30 am
VUD-, Delhi—11.95 N 25.10
——, Moscow—11.94 25.10—9.40-10.54 pm
ZPA-5, Enc'nac'n—11.95 25.10—Heard around 10.30 am
KKQ, Bolnas—11.95 25.10
GUX, London—11.95 S 25.15—7.15-9 am
???X, 'Frisco—11.9 S 25.21—8.30 am-2 pm
VLG-9, M'bourne—11.90 N 25.21—Idle at present.
WRCA, New York—11.89 25.22—5-6.45 am; 7-11.45 pm
VPD-2, Suva—11.90 25.22—8.30-10 am.
WKTM, New York—11.89 S 25.23—Think idle at present.
AFHQ, Algiers—11.88 X 25.24
VLR-3, M'bourne—11.88 S 25.25—Daily, 11.45 am-5.45 pm; Sundays 12.50-5.45 pm
WOOW, New York—11.87 S 25.27—7.15-8.45 am; 9.45 pm-7 am
WBOS, Boston—11.87 S 25.27—7.45-9.30 pm
VUD-8, Delhi—11.87 25.27—7.30-10.30 pm
KWIX, 'Frisco—11.87 S 25.27—6.15-8.30 am
HER-5, Berne—11.86 25.28—10.55 pm-12.30 am
GSE, London— S 25.29—8 pm-4.30 am; 4.45 am-12.15 pm
WGEX, S'tady—11.84 S 25.33—8 pm-1.45 am
WGEA, S'tady—11.84 S 25.33—7 am-1.30 pm; 2-6.45 am.
VLG-4, M'bourne—11.84 25.34—6.10-7 pm; 7.30-9.45 pm
GWQ, London—11.84 S 25.36—10.45 pm-1.15 am
VLW-3, Perth—11.83 S 25.36—1.30-8.15 pm (Sun. from Noon)
——, Moscow—11.83 S 25.36—Heard at 3 and 11 pm.
WCRC, New York—11.83 25.36—7.30 am-2 pm; 9 pm-7.15 am
WCDA, New York—11.83 S 25.36—Idle
GSN, London—11.82 S 25.38—3.45-8 pm; 4-6 am

(Continued on page 32)

ANNOUNCING

A MAJOR TECHNICAL IMPROVEMENT "PERMACLAD" by KINGSLEY

Kingsley announce "Permaclad" I.F. Units, Coils, etc., representing one of the most important contributions to Radio Component Manufacture in recent years. Complete stocks are now being made available from our Authorised Distributors throughout Australia.



FEATURES

★ "Permaclad" Components show "Q" values approx. 33% greater than the conventional type of Units. This means less loss.

★ The restriction of the magnetic field by the "Permaclad" principles permits a smaller shield to be used without affecting the inductance or "Q" values.

★ "Permaclad" Units are smaller than the conventional type units.

★ "Permaclad" Units are specially designed for "replacement" work.

It will be of interest to many of those in the Radio Industry to note that Mr. Lay Cranch, A.M.I.R.E., has joined Kingsley as the Research Engineer of Parts Division and that "Permaclad" was brought to a successful conclusion under his guidance.

KINGSLEY RADIO PTY. LTD.

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380 St. Kilda Road, Melbourne, Vic. **Telephone: MX 1159**

Shortwave Review

CONDUCTED BY
L. J. KEAST

NOTES FROM MY DIARY

THE BLOKE WITH THE LONG WHITE BEARD

Noticing how the tints on my Christmas Bush were suddenly taking on a deeper red, I remembered that this will be the final issue for 1944.

Last year we were hoping for a White Christmas and many a bridge has been crossed since then, the remarkable progress of the troops in all theatres of war suggesting we can reasonably hope that Christmas 1945, will be white. Here's wishing all readers of these pages a Very Merry Christmas and a Happy New Year.

THE GUY THAT READS EVERYTHING

There will be many a reader of these pages who can recall Walter Kelly "The Virginian Judge," that great raconteur who amused and interested us on the old Harry Rickards' Tivoli circuit. Well, just such a fine story teller is Gaylon Drake, the guy that reads everything and crams some great yarns into fifteen minutes under the title "Service Digest." He can be heard on Tuesdays at 11.15 a.m. over KROJ, 17.76 mc, and at 5.30 through KGEI, 11.73 mc.

THE EVER BENDING BEAM

It is palpably plain that as the American Forces move further north the 'Frisco beam follows them. This is only to be expected and the large area covered can be gathered by the announcements from the various transmitters covering the Pacific.

The principal ones are:

KROJ, 17.76 mc, 16..89 m—11 am-1.45 pm, to the S.W. Pacific.

KGEI, 11.73 mc, 25.58 m—3 pm-5.45 pm, Phillipines.

KES-3, 10.62 mc, 28.25 m—3-8.30 pm, Philippines.

KWV, 10.84 mc, 27.28 m—4-7.15 pm, Australia.—7.30-9 pm, N.E.I.

KRCA, 9.49 mc, 31.61 m—4 pm-2.30 am, N.E.I.

KWIX, 9.855 mc, 30.44 m—6-8.30 pm, Central Pacific.

KGEI, 15.13 mc, 19.83 m—6-8.30 pm, S.W. Pacific.

KROJ, 9.89 mc, 30.31 m—6-11 pm, South Pacific.

KGEX, 7.25 mc, 41.38 m—7 pm-12.45 am, Philippines.

KES-2, 8.93 mc, 33.59 m—7 pm-12.45 am, N.E.I.

KWID, 7.23 mc, 41.49 m—7.15 pm-1 am, Orient.

KGEI, 9.53 mc, 31.48 m—8.45 pm-3 am, Orient.

SHORTWAVE REVIEW

OCEANIA

Australia.

As from November 8th, VLI Sydney transmitters were withdrawn and Melbourne (VLG-) and Shepparton (VLC-) are being used for Overseas transmissions. One or two changes in schedules are noted:

VLC-4, 15.315 mc, 19.59 m: Opens at 8.30 am instead of 9 and an additional session is 11.45 am-12.45 pm replacing VLC-5 in latter session. One of the best signals on the air from 10-10.15 am is news for the Philippines.—L.J.K.

Excellent at 1 pm with news for the Forces (Ferguson). VLW-6, Perth, 9.68 mc, 30.99 m: Excellent at 8.30 pm (Ferguson).

FIJI

VPD-2, Suva, 6.13 mc, 48,94 m: Good at 6.30 pm (Matthews). (New schedule according to "N.Z. Dxtra" is: Mon.-Fri., 6.10-7 am with news. Sundays, 3.25-7.30 pm; Tuesdays, 6-7 pm in Fijian.—L.J.K.)

(Continued from page 29)

XEBR, H'mos Illol.—11.82 25.38—11 pm-3 pm

Call Sign Location Mc. M. Time: East. Australian Stand'd

ZOJ, Colombo—11.81 N 25.40—8 pm-2 am
OBH, Havana—11.80 25.41—Around 8 am and 9.30 pm
WH, London—11.80 S 25.42—5.30-6.30 pm; 9.45-10.15 pm; 11-11.15 pm; 12.30-1.30 am
WRUA, Boston—11.79 S 25.45—8-9.30 pm; 9.45 pm-3.30 am; 3.45-6.30 am
VUD-7, Delhi—11.79 25.45—7.45 pm-M/N
KGEI, 'Frisco—11.79 25.45—Think idle at present.
GVU, London—11.78 S 25.47—9 am-noon; 5 pm-3.45 am
HP5G, Panama—11.78 25.47—2.45-6 am
HER-, Berne—11.78 25.47
VLR-8, M'bourne—1.1.76 25.51—Daily, 6-10 am (Sun. 6.45 am-12-45 pm)
VUD-5, Delhi—11.76 25.51—1.15-5.30 pm
GSD, London—11.75 25.53—3-6 pm; 7 pm-1.15 am; 1.30-6.30 am
——, Moscow—11.75 25.53
HVJ, Vatican City—11.74 25.55—Calls Aust. Tues. & Sats. 4 pm
COCY, Havana—11.73 25.56—11 am-4.15 pm
GVV, London—11.73 25.58—4.45-7 pm; 8-10.45 pm
WRUL, Boston—11.73 25.58—4.45-8 am; 8.15-9.15 am; 9.30 am-4 pm
KGEI, 'Frisco—11.73 N 25.58—3-5.45 pm
CKRX, Winnipeg—11.72 25.60—3-7.45 am
OPL, Leopoldville—11.72 25.60
Brit. Medit—11.72 25.60—10.45 pm-6.30 am; 1.45-3.35 pm
HEI-5, Berne—11.71 S 25.61—Tues. & Sats., 6-7.30 pm
PRL-8, Rio de Janeiro—11.71 25.61—Heard from 5 am till closing at 6.10
YSM, San Salvador—11.71 25.62—4-5 am
VLG-3, Melbourne—11.71 S 25.62—11.45 am-12.45 pm; 3.10-3.45

Call Sign Location Mc. M. Time: East. Australian Stand'd

pm; 4-4.40 pm; 4.45-5.25 pm; 5.30-5.55 pm; 1-1.45 am
WLWO, C'nnati—11.71 25.62—4.45-7.15 am
WLWK, C'nnati—11.71 25.62—8.45-10.15 pm
CXA-19, Montevideo—11.70 25.63
SBP, Motala—11.70 25.63
CBFY, Montreal—11.70 25.63
GVW, London—11.70 25.64—4-6 am
HP5A, Panama—11.70 25.64—11 pm-3 am; 11.10 am-3 pm
CE1170, Santiago—11.70 25.64—10 pm-M/N
FZI, Brazzaville—11.687 N 25.66—4-8.45 am
GRG, London—11.68 S 25.68—3-6 pm; 8-10 pm; 12.45-3.45 am
RNB, Leopoldville—11.64 25.77—3-3.45 pm
VUD-, Delhi—11.64 N 25.77—Not heard lately
Leningrad—11.63 25.79—Irreg. night and morning
COK, Havana—11.62 25.83—2 am-1 pm
Radio Dakar—11.41 S 26.29—5.15-7.20 am
HBO, Geneva—11.40 N 26.31—Idle.
WRUA, Boston—11.14 S 26.92—Idle
WCBN, New York—11.14 S 26.92—7.30-9.15 am
WCDA, New York—11.14 26.92—Idle
CSW-6, Lisbon—11.04 27.17—5-8.30 am
KWV, 'Frisco—10.84 27.68—4-7.15 pm; 7.30-9 pm
SDB-2, Stockholm—10.77 27.83—Around 3.45 am
VQ7LO, Nairobi—10.73 27.96—12.45-5 am
KES-3, 'Frisco—10.62 S 28.25—3-8.30 pm
——, Moscow—10.44 28.72
HEO-4, Berne—10.338 F 29.01—5.40-6.15 am
ZFD, Bermuda—10.33 29.03—Heard around 6 am
——, Moscow—10.23 29.33
——, Moscow—10.10 29.68
——, Moscow—10.08 29.75
SUV, Cairo—10.05 29.84—4.30-5.30 am
WJQ, New York—10.01 N 29.97—Around 7.15 am
WWV, Washington—10.00 30.00—Freq. check

New Guinea.

XBC heard on 16, 20, 23 and 40 metre bands (Gaden, Ferguson).

New Zealand.

ZLT-7, Wellington, 6.715 mc, 44.68 m: Fair at 7.30 pm with news but unreliable (Ferguson).

AFRICA.

Algeria.

AFHQ, Algiers, on 9.60 mc, 31.21 m and 9.535 mc, 31.46 m, has been logged at 8 am with the U.S. programme "America To-day". Strenth good (Gillett).

Belgian Congo

OPL, Leopoldville, 15.17 mc, 19.78 m: Good at 9 pm (Matthews).

OPL, Leopoldville, 9.785 mc, 30.66 m: R 9 Q 5 in French at 2 am (Edel).

OPL, Leopoldville, 9.39 mc, 31.95 m: Good at 2 am (Matthews, Edel).

French Equatorial.

FZI, Brazzaville, 15.595 mc, 19.25 m: English at 10.15 pm and on 11.97, 11.68 and 9.44 mc: Good in morning with English at 10.30 am (Matthews).

FZI, 11.97 mc, 25.06m: Heard in Arabic at 2.30, French 2.41. At 2.43 announces "News in German for Austria and German speaking countries" (Edel).

Kenya Colony.

VQ7LO, Nairobi, on 10.73 mc, 27.96 m, and 6.11 mc, 49.07 m: Heard in Polish until signing off at 1.15 am. Returned at 2.15 giving full schedules in English (Edel).

Madagascar.

Radio Antananarivo, 12.13 mc, 24.74 m: This station reported last January by Mr. Edel is in the limelight again. If near-by station and morse will permit is heard around 10.45 pm with fair signal. Dr. Gaden and Mr. Wally Young reported it but were doubtful if location was actually the capital of Madagascar.

Mozambique

CR7BE, Lourenco Marques, 9.863 mc, 30.42 m: Heard on several occasions at 5.50 am with signal equal in strength to local station. News is given at this time and popular American shows are often broadcoast (Gillett).

INDIA.

See article giving full frequencies of A.I.R.

SEAC, Colombo, 15.275 mc, by day and 11.81 at night, the 10.15 pm news being excellent (Gaden).

GREAT BRITAIN.

GVR, 21.675 mc, 13.84 m: Has been heard nicely at 7.45 pm—too much "swish" every time I listen to it (Gaden). Excellent from 7-10 pm (Matthews).

GSH, 21.47 mc, 13.97 m: Not so good (Gaden).

GSV, 17.81 mc, 16.84 m: Excellent strength 7-11 pm (Matthews). (Schedule is 5 pm-1.30 am and from 8-10.30 is intended for Australia.—L.J.K.)

GVQ, 17.73 mc, 16.92 m: Is best on 16 metre band from 11 pm (Matthews).

GWE, 15.43 mc, 19.44 m: Good all evening (Matthews).

GWR, 15.30 mc, 19.61 m: Putting in a beautiful signal from 8-9.15 pm.—L.J.K.

GSO, 15.18 mc, 25.68: Good at night (Matthews).

GRX, 9.69 mc, 30.96 m: Good in Pacific Service at 5 pm (Ferguson). (As from 26th November schedule is extended to 6.30 pm—L.J.K.)

GWP, 9.66 mc, 31.06 m: Excellent in "London calling Europe" at M/N (Matthews).

GWB, 9.55 mc, 31.41 m: English by Radio, 4.10, 5.10 and 9 pm and 4.45 am.—L.J.K.)

GSB, 9.51 mc, 31.55 m: Good in morning (Matthews).

GRU, 9.455 mc, 31.73 m: Good around M/N (Matthews). Is now intended for N.Z. and Pacific from 8 pm-M/N.—L.J.K.)

GRM, 7.12 mc, 42.13 m: Has now been added to the transmitters using English and Japanese at 9 pm (Edel).

London has been read on 49.67 metres, opening at 6.15 am with ...— and announcing as "Ici Londres" (Gillett).

Further stations believed by reporters to be BBC transmitters that I have referred to the BBC representative in Sydney are:

15.21 mc, 19.72 m; 15.095 mc, 19.87 m; 12.36 mc, 24.26 m; 12.020 mc, 24.95 m; 9.609 mc, 31.22 m, and 5.80 mc, 51.72 m.—L.J.K.

U.S.S.R.

Mr. Matthews, of Perth, reports Moscow on 15.75 mc, 19.05 m, and 15.37 mc, 19.51 m as good at 9.40 pm.

On 12.26 mc, 24.47 m, some very fine operatic items can be heard from early evening.—L.J.K.

Most evenings I hear Moscow on 11.630 mc, 25.79 m (Edel).

SOUTH AMERICA

Brazil.

PRL-8, Rio de Janiero, 11.71 mc, 25.60 m: "The Voice of Brazil" is heard at surprisingly good strength at 6.10 am when closing. English is used every day at 5.30 am, except Mondays. Reports are asked for. Address: Radio Nationale, Rio de Janiero, Brazil (Gillett). Heard fairly well in early am (Gaden).

PRL-7, Rio de Janiero, 9.72 mc, 30.86 m: Also heard fairly well in the early am (Gaden).

Chile.

CE970, Valparaiso, 9.73 mc, 30.82 m: Heard weakly now at lunch time. Is still on at 2 o'clock but cannot hear at 3 (Gaden).

Ecuador.

HCJB, Quito, 12.44 mc, 24.08 m: Heard early am, mid-day and around 10 pm much better than on 30.12 m (Gaden).

U.S.A.

'Frisco Stations.

KROJ, 17.76 mc, 16.89 m: Nice at 11 am (Matthews).

KGEX, 15.33 mc, 19.57 m: Fair in the mornings (Matthews).

KGEI, 15.13 mc, 19.83 m: Not much good (Gaden, Perkins). (Some evenings I have copied KGEI from opening at 6 till closing at 8.30 but very seldom.—L.J.K.)

KGEI, 15.29 mc, 19.62 m: Good in the morning (Matthews).

KGEI, 11.73 mc, 25.58: Has been O.K. in afternoon (Gaden, Ferguson) (Perkins). (Down here, has opposition when opening at 3 o'clock from WRUL and towards closing from GVV, but some days is excellent.—L.J.K.)

KGEI, 9.53 mc, 31.48 m: Not much good (Gaden) (Perkins).

KWV, 10.84 mc, 27.68 m: Excellent with news at 5 pm (Ferguson).

KGEX, 7.25 mc, 41.38 m: Good all night (Matthews). (Some nights has a little heterodyne from a station I have not so far identified; gets clearer as night goes on.—L.J.K.)

KROJ, 6.10 mc, 49.15 m: Still the victim of bad heterodyne (Perkins). (Yes, I wish the offending station would give his call-sign. Have followed him till after 1 o'clock but beyond some good operatic items now and then nothing of interest and certainly no idea of who he is.—L.J.K.)

NEW STATIONS

WVLC, Leyte, 18.60 mc, 16.14 m: Another outlet used by Gen. MacArthur's Headquarters. Heard around 8 and 9.30 am.

WNRA, New York, 18.16 mc, 16.52 m: This National Broadcastng Company transmitter first heard early in November, closing at 7.15 am. At 7 am were in parallel with WNRX, 20.61 m, WNBI, 31.02 m., and WRCA, 19.81 m.—L.J.K.

WCRC, New York, 8.16 mc, 16.52 m: Reported heard around 12.15 am.

WLWR, Cincinnati, 17.96 mc, 16.70 m: This is a new one for The Crosley Corporation and is reported by Mr. Ern Suffolk in "Radio Call" as heard with recorded music at 3 am.

WGEX, New York, 17.89 mc, 16.77 m: Although not actually a new station I think this is the first time it has been reported heard in Ausralia. Wally Young of Adelaide, tells me he logged them around 5.45 am.

CHANGES IN BBC PACIFIC SCHEDULE

As from November 26th—

GRM, 7.12 mc, 42.13 m continues till 6.30 pm.

GRX, 9.69 mc, 30.96 m continues till 7 pm.

GWD, 15.42 mc, 19.46 m, opens at 6.45 pm.

GVY, 11.955 mc, 25.09 m, has been withdrawn.

Here is a list of

All India Radio Transmitters

in frequency order that should make for quick refernce:

D—Delhi; B—Bombay; C—Calcutta; M—Madras.

VUD-5	17.83 mc,	16.83 m.
VUD-8	15.35 mc,	19.54 m.
VUD-3	15.29 mc,	19.62 m.
VUD-5	15.19 mc,	19.74 m.
VUD-	15.16 mc,	19.79 m.
VUD-	11.95 mc,	25.10 m.
VUD-8	11.87 mc,	25.27 m.
VUD-6	11.83 mc,	25.36 m.
VUD-7	11.79 mc,	25.45 m.
VUD-5	11.76 mc,	25.51 m.
VUD-7	9.63 mc,	31.15 m.
VUD-4	9.59 mc,	31.28 m.
VUM-2	9.57 mc,	31.35 m.
VUB-2	9.55 mc,	31.4 m.
VUC-2	9.53 mc,	31.48 m.
VUD-5	7.30 mc,	41.10 m.
VUD-5	7.275 mc,	41.24 m.
VUM-2	7.27 mc,	41.27 m.
VUB-2	7.24 mc,	41.44 m.
VUD-6	7.215 mc,	41.61 m.
VUC-2	7.215 mc,	41.61 m.
VUD-7	6.19 mc,	48.47 m.
VUM-2	6.065 mc,	49.34 m.
VUC-2	6.21 mc,	49.92 m.
VUD-2	4.96 mc,	60.48 m.
VUM-2	4.92 mc,	60.98 m.
VUB-2	4.88 mc,	61.48 m.
VUD-3	4.86 mc,	61.73 m.
VUC-2	4.84 mc,	61.98 m.
VUD-2	3.495 mc,	85.84 m.
VUM-2	3.435 mc,	87.34 m.
VUB-2	3.385 mc,	89.15 m.
VUC-2	3.305 mc,	90.77 m.

South East Asia Command
Colombo Ceylon
SEAC 15.275 mc, 19.64 m.
11.81 mc, 25.40 m.
Kandy Ceylon
15.275 mc, 19.64 m.

ALL-WAVE ALL-WORLD DX CLUB

APPLICATION FOR MEMBERSHIP

The Secretary,
All-Wave All-World DX Club,
243 Elizabeth Street, Sydney.
Dear Sir,

I am very interested in dxing, and am keen to join your Club

Name..

Address..

(Please print both plainly) ....

....

My set is a..

I enclose herewith the Life Membership fee of 2/– (Postal Notes or Money Order), for which I will receive, post free, a Membership Certificate showing my Official Club Number. NOTE—Club Badges are not available.

(Signed)..

(Readers who do not want to mutilate their copies can write out the details required.)

SPEEDY QUERY SERVICE

Conducted under the personal supervision of A. G. HULL

E.R.H. (Eton Springs) rips into us about not keeping promises.

A.—Yes, things are tough. We appreciate your feelings, but these accidents are quite unavoidable under the present circumstances. It is not the slightest use writing for the information, for if we had it, we would undoubtedly print it and save ourselves all this sort of bother.

* * *

C.R.H. (New Zealand) wants to know if the "Rola" G12 is suitable for the Compensated Acoustic circuit in our March, 1941, issue.

A.—The circuit was designed around the K12 and it would be better to use this model if available. Otherwise you may run into trouble in two directions. Firstly, the voice coil impedances are different and since the feedback comes from the voice coil circuit the matter is fairly critical. Then you will also run into bother in regard to energising power. For best results from a heavy speaker you need to use plenty of energising power, up to 20 watts. This power is not available with normal power transformer equipment and normal voltage distribution for the high tension supply to the set. If you are going to have less than ten watts of energising power in the field coil you might just as well use a K12.

* * *

A.E.P. (Bexley) has a technical article in mind.

A.—Sorry to be so long in answering your letter, but you can imagine what a problem it is these days to get around to doing things. Technical articles on any subject of interest to our readers are welcomed and will be paid for at not less than journalist's award rates, and much higher in all cases where the article has special appeal. Not much use writing about the ordinary routine stuff, but a description of a special bit of test equipment sounds o.k. If you are any good at draughtsmanship you can do the diagrams in indian ink, but if at all doubtful about how they will reproduce, it is better to make rough pencil diagrams and leave the rest to us.

* * *

F.G. (Bondi) asks whether hum-bucking devices proved successful.

A.—Hum bucking stunts do not appear to be popular, but we can't explain why. Some of them can be most effective and we all know how desirable it is to have freedom from hum. One of the schemes which was used extensively about fifteen years ago was to have an adjustable centre-tapping for the output valve, in those days the power valve having a directly-heated filament.

* * *

P.D.N. (Mosman) sends along a theoretical circuit for an amplifier to beat the cathode follower suggestion.

A.—Many thanks for the effort. Apparently you are a most keen enthusiast. Unfortunately we haven't had time to delve through the formula thoroughly, but we do hope that you haven't mis-applied any of it, as so often happens in the radio game. We never feel safe about these things until they have proved themselves in practice as well as theory. Take for example all the theory that has been written about inverse feedback, but when you get a couple of amplifiers ranged up alongside of each other and change from one to the other the ear will pick out the triode job as having less distortion, other things being equal. Look at the results of the amplifier contests, too. Then again take the performance of direct-couplers, as they have something which we have never seen adequately covered by theoretical considerations. So long as you keep it in its right perspective, however, the theory is good stuff and adds to the interest. Keep it up.

* * *

R.L.T. (Merriden) asks whether he can use a 6 volt vibrator on a 12 volt battery and thereby increase his high tension output.

A.—We don't think there is the slightest chance of the vibrator unit standing up to such abuse. The contacts and transformer would be overloaded terrifically. They give trouble enough even when working at their normal ratings. You might consider working two units in series, but it sounds messy to us.

* * *

G.H. (Glenroy) asks why designers appear to prefer the 6C6 as on audio amplifier.

A.—Yes, we have noticed that overseas designers seem to prefer the 6C6 to the 6J7G. They must be paying attention to detail as there is not a great deal of difference in the published characteristics. Probably the difference lies in inter-electrode capacities. Likewise with the earthing of the suppressor grid, as this does not appear to make much difference in practice and a great many people specify the suppressor tied directly to the cathode, whilst a few of the extra careful designers seem to favour earthing of this element.

* * *

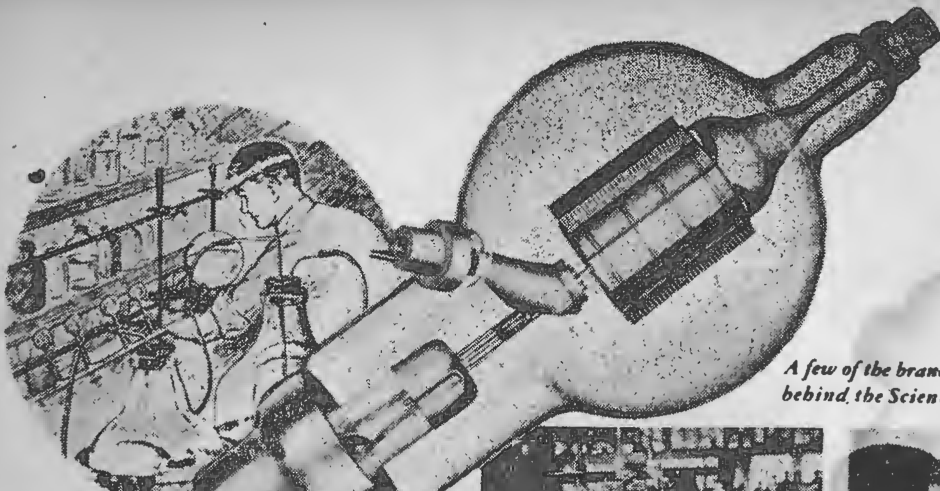
R.F.M. (Mildura) is interested in building a modulated oscillator for service work.

A.—Full details of a suitable oscillator, using two 6J7G valves and one 5Y3, were given in our issue of January, 1940, copies being still available from this office at 1/- each, post free. Full coil winding data was given for all bands from 12 metres to 110 kilocycles, which covers all practical signal and intermediate frequencies. No litz wire is called for, and so you should have little trouble in getting the required materials. Properly built, adjusted and calibrated this instrument should be equal to any of the ordinary commercial jobs.

* * *

T.D. (Narromine) wants to know how many turns.

A.—Unfortunately it isn't as easy as all that. In order to compute the necessary coil windings you will first need to know the frequency to which you intend the circuit to resonate, then to know the capacity in the circuit. Given these it is possible to calculate the required capacity, but a fairly difficult formula has to be worked out, quite hopeless as you say you haven't any knowledge of mathematics. Then it is necessary to again resort to mathematics to calculate the coil design, and you must have a basis to work on, such as the length of winding proposed, the diameter of the former and so on. It might be possible for some energetic person to work out a table of these things which would be of great help to you and other readers similarly placed, but manpower shortage makes it difficult at the moment. Will keep the idea in mind for the future.



A few of the branches of the Science behind the Science of Electronics

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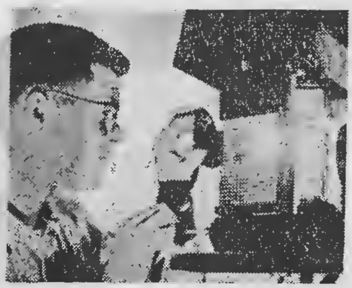
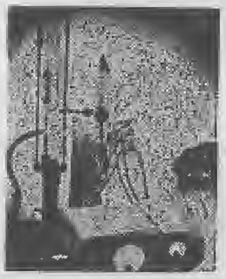


METALLURGY – *Spectrographic Analysis of the Rare Metals Used in Vacuum Tubes*



VACUUM TECHNOLOGY – *Constant Research to Develop Better Vacuum Techniques*

PHYSICS – *Actually Viewing Emission of Electrons with Electron Microscope*

ELECTRONICS – *Determining Facts about and Recording Data on Vacuum Tube Capabilities*

OPTICS – *Studying the Effect Processing has on the Structure of Materials Through Photomicrographs*

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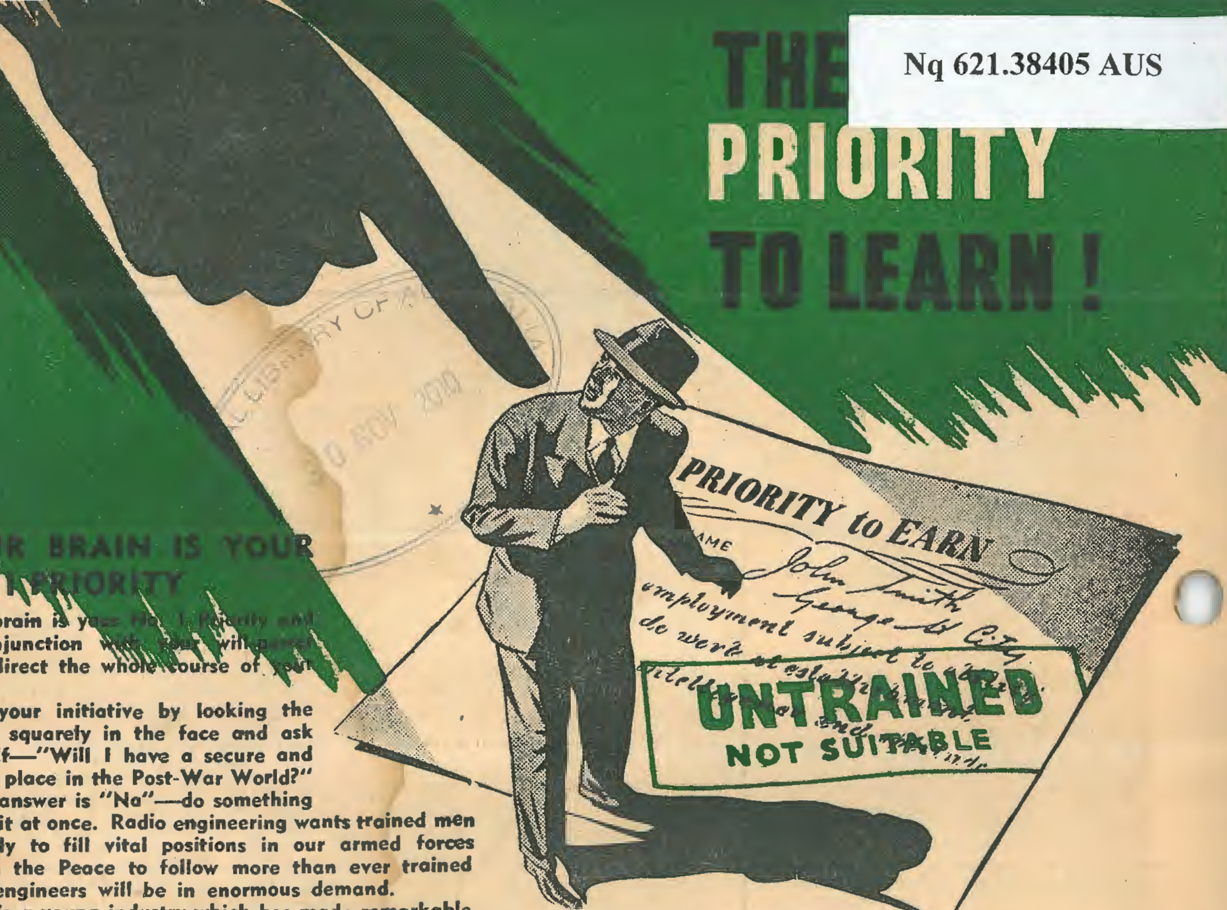

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